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Effects of Visitors and Enrichments on Behavior of Captive Red Wolves' (Canis rufus) at the Great Plains Zoo, Sioux Falls, South Dakota

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EFFECTS OF VISITORS AND ENRICHMENTS ON BEHAVIOR OF CAPTIVE RED WOLVES' (*Canis rufus)* AT THE GREAT PLAINS ZOO, SIOUX FALLS, SOUTH DAKOTA

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This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science in Biological Sciences degree and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusion of the major department.

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ABSTRACT

EFFECTS OF VISITORS AND ENRICHMENTS ON BEHAVIOR OF CAPTIVE RED WOLVES' (*Canis rufus)* AT THE GREAT PLAINS ZOO, SIOUX FALLS, SOUTH DAKOTA

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Red wolves (*Canis rufus*) are the first animals to maintain a wild population from captive, released individuals. A captive breeding program for red wolves was started before complete extirpation, and 4 breeding pairs were released in Alligator River National Wildlife Refuge (North Carolina) in 1987 and a small wild population still exists there. Currently, there are several captive breeding facilities for red wolves within the Species Survival Plan (SSP) program. The Great Plains Zoo in Sioux Falls, South Dakota participates in the SSP program. My study was initiated to create a natural history background and evaluate interaction between red wolves and visitors to the zoo. I also evaluated captive management resources to enhance natural behavior of red wolves while in captivity. My study focused on a breeding pair in 2012 and the breeding female and 2 of her offspring in 2013. Objectives were to create an ethogram to describe red wolf behavior, investigate the effects of human visitors on captive red wolves, and to identify what zoo enrichments were beneficial for encouraging red wolves to display active behaviors. I used direct observation of red wolves to create an ethogram of specific behaviors. I documented changes from desirable to undesirable behaviors that occurred when zoo visitors were present at the red wolves' exhibit. I added selected enrichments to the wolves' enclosure and recorded their behavior in 4 categories: auditory, olfactory,

environment, and food. Enrichments were chosen based on the Association of Zoos and Aquariums' large canid care manual to promote appropriate behaviors. Visitors were present for 49% of the 405 hours of observation. While visitors were present, negative behavior of all red wolves increased (Chi-sq. = 476; $p < 0.001$). In order to enhance desired behavior, it may be necessary to keep visitors away from red wolves that will be released into the wild. Auditory and environmental enrichments were most beneficial for the females, while olfactory and feeding enrichments were most beneficial for the juvenile male. Further research should be done to determine other enrichments which may be beneficial in creating desired behaviors in captive red wolves.

INTRODUCTION

The red wolf (*Canis rufus*) was listed as an endangered species in 1967 (USFWS 2006). Red wolves were officially declared extirpated from the wild in 1980, and as of today there is only 1 wild population in North Carolina's Albemarle Peninsula (USFWS 2006, 2014). In the late 1960's to 1970's, the last 17 red wolves were brought into captivity due to habitat loss in their range and excessive mortality from predator control on coyotes (*Canis latrans*) (Patent 1990, USFWS 2006). Two subspecies, eastern Florida (*C. rufus floridanus*) and western Texas (*C. rufus rufus*) are now extinct, while the central Mississippi Valley (*C. rufus gregoryi*) subspecies still survives (Mech 1970, Patent 1990). The original range of red wolves was as far north as Pennsylvania and Illinois, west to central Texas and Oklahoma, east to the Carolinas, and south to Florida (Figure 1) (Nowak et al. 1987, Bauer 1988, Grooms 1999). Natural habitat of red wolves includes deciduous and hardwood forests, wetlands, and coastlines (Bauer 1994).

Point Defiance Zoo and Aquarium in Tacoma, Washington initiated a coordinated breeding program in 1969 which resulted in 14 of the 17 red wolves being used as breeding stock; not all individuals were determined to be genetically pure red wolves (USFWS 2006). Up to 60 wolves live in North Carolina's Alligator River National Wildlife Refuge (ARNWR) from the original 4 breeding pairs released in 1987 (Patent 1990, USFWS 2013, 2014). ARNWR was chosen as the most suitable relocation site because coyotes were absent there until the 1990's (Bauer 1988, USFWS 2006). A previous release on Bull Island, part of Cape Romain National Wildlife Refuge, South Carolina, ended with all individuals dying or leaving the area (Bauer 1988, 1994, Patent 1990). The wolves released in ARNWR were part of the first reintroduction of an

officially wild extirpated species back into the wild (USFWS 2006). The first wild litter was born in 1988, and most of the current wild population originated from wild breeding pairs (USFWS 2006).

Red wolves' coats are short, and colors are a mix of cinnamon (red), brown, black and gray (Bauer 1988, Patent 1990). Red wolves are smaller (18-34 kg) than gray wolves (*Canis lupus*) and larger than coyotes, with a slim body, big ears, and long legs (Nowak et al. 1987, Bauer 1988, Grooms 1999). Red wolves act more like gray wolves than coyotes; they have a pack led by a breeding pair, hunt in pairs, and defend territories from 2,590 to 5,180 hectares (USFWS 2006). Red wolves hunt primarily at night and are more secretive than gray wolves (Bauer 1988, Grooms 1999). Red wolves and coyotes resemble each other but differ in several ways. Red wolves are longer from nose to tail, taller, heavier, and have a different muzzle than coyotes. From the tip of the nose to the base of the tail, red wolves average 1.22 meters long while coyotes average 0.91 meters long (U.S. Fish and Wildlife Service [USFWS] 2006; 2008). Distinct differences can be seen in the skull:brain ratio, and their brain case appears smaller due to a broader snout and nose than a coyote (Mech 1970, Bauer 1988). Coyotes are also less massive looking in the chest, legs, head, and feet than adult red wolves (USFWS 2006). Unfortunately, young red wolves can be mistaken for coyotes when they are an intermediate size before maturity (USFWS 2008).

Red wolves can hybridize and produce viable, fertile offspring with coyotes and other canines including gray wolves and domestic dogs (Bauer 1994, Grooms 1999, USFWS 2006). As the range of coyotes increased in the southeastern United States, hybridization with coyotes was a major cause of their extirpation (Mech 1970, Nowak et

al. 1987, Grooms 1999, USFWS 2006). The USFWS tried to reduce the number of hybrids by hiring trappers to catch hybrids or coyotes, yet due to physical similarities many red wolves were accidently destroyed (Grooms 1999). Young red wolves and coyotes are similar in color and size, making it difficult for hunters to tell them apart (USFWS 2008). Wildlife biologists have managed the red wolf population and red wolf-coyote hybridization since 2005 to keep the restored population pure and viable. To minimize coyote hybridization, the USFWS is sterilizing territory-holding coyotes. Instead of destroying the coyote, the newly sterilized coyote acts as a placeholder to deter new, fertile coyotes from entering into red wolf area. If the sterile, territory-holding coyote does mate with a red wolf, no hybrid offspring will be born. Another way biologists are managing the population is by detecting hybrid litters before their dispersal. This action decreases the chance of further hybridization. Increasing the number of wild red wolves by reintroduction. Pup fostering from captive parents into wild litters is another way the USFWS is trying to maintain the red wolf genetic diversity (USFWS 2006).

The red wolf's Species Survival Plan (SSP) started on December 31, 1984, with a Stud book started in 1982 (Association of Zoos and Aquariums [AZA] 2009b). There are 43 SSP facilities helping expand the population of *C. rufus* (USFWS 2013, 2014). The Red Wolf Recovery plan's goals are to have at least 550 individuals; 220 wild and 330 captive (Patent 1990, USFWS 2006). There are currently 194 red wolves in SSP facilities and 45-60 wild red wolves (USFWS 2006, 2014). The red wolf is being used as a blueprint for other endangered species management and recovery programs (USFWS 2006). The Great Plains Zoo, in Sioux Falls, SD, participates in the red wolf SSP.

Captive facility studies can assist in breeding programs like the SSP and captive management practices for zoo and other captive facilities' personnel. Descriptive behavior studies in captivity can create baselines of behavior to compare to wild counterparts or see trends across taxa (Hosey 1997). Small sample sizes are not uncommon in studies with endangered animals in zoos. Despite being labor intensive, copious amounts of observations of each individual reduce variability (AZA 2009a). Combining research animals from different zoos is unfavorable in this study for statistical reasons. At each zoo there are different group dynamics, different housing and viewing conditions adding undesired, compounded variability to the data for the short research time (Hosey 1997). The constant exhibit and same individuals on exhibit daily allow for a less variable study (Hosey 1997).

The zoo setting allows visitors a chance to see endangered and threatened animals. Human behavior is a large and unpredictable variable related to animal interaction in a zoo setting (Hosey 2000). The mission of zoos is to increase animal education and conservational awareness in the public. Public attendance allows zoos and similar institutions with the continuation of funding. Animals need to be on display for visitors' satisfaction or funding may decrease with decreases in visitors. The forced close proximity of visitors to red wolves and other zoo animals is necessary to elicit empathy and desire to protect endangered animals (Morgan and Tromborg 2007). However, visitors' presence can have different effects on the animals including increased stress, provide enrichment, or be neutral (Hosey 2000, Morgan and Tromborg 2007). The human-animal relationship (HAR) concerning zoo animals' welfare is an important subject. In a public setting like a zoo, a researcher has little to no control over the

behaviors and actions of the public visitors on the animals being observed. Human interaction can be enriching for domesticated species, but little is known what the effects on wild, captive animals are (Claxton 2011). As visitors' numbers increase, an animal often paces, retreats from view, increases aggression, or exhibits other undesirable behaviors (Morgan and Tromborg 2007, Fernandez et al. 2009). Studies on the effects of visitors' presence on captive animals are important for species such as red wolves (Hosey 2000). With the endangered status of the red wolf, several zoos maintain a breeding stock for future reintroductions. The effects that visitors' presence on endangered animals, such as the red wolf, needs to be explored.

Behavioral (or environmental) enrichments are stimuli based on specific species to increase physical and cognitive activity (AZA Canid Taxon Advisory Group [TAG] 2012). Enrichments can be tactile, environmental, olfactory, auditory, social, or food related stimuli. Enrichments can be physical objects to manipulate with paws or teeth, the addition of different substrates in the exhibit, scents and sounds from the same or other species, and by providing food in different manners such as in ice or in a foraging manner (AZA Canid TAG 2012). Duration and placement of enrichments in an exhibit are important to specific species and desired outcomes (Tarou and Bashaw 2007). Since red wolves are involved in wild reintroductions, no non-natural scents or formal animal training should be used as these would habituate the animals towards humans (AZA Canid TAG 2012). Enrichment schedules need to be varied and sometimes it is best to remove the enrichment before behavioral extinction to decrease habituation and effectiveness of the enrichment (Tarou and Bashaw 2007, AZA Canid TAG 2012). There

are a lack of data on enrichments to facilitate natural behavior in red wolves (Mason et al. 2007).

The objectives of my study were to (1) create an ethogram describing red wolf behavior, (2) investigate the effects of human visitors on captive red wolves, and (3) identify what zoo enrichments were beneficial for encouraging red wolves to display active behaviors. These data will help captive facilities have better information on maintaining a quality captive environment for red wolves.

MATERIALS AND METHODS

I directly observed red wolves at the Great Plains Zoo in Sioux Falls, South Dakota. The wolves were fed a commercial carnivore diet including ground meat every morning before visiting hours. Their outside exhibit (278 m^2) had natural substrates including soil, mixed vegetation (grasses and trees), large rocks, a concrete pool, a concrete culvert, and a wooden den box with straw bedding. The fencing was covered in coated mesh. Such enclosures do not significantly alter gray wolf behavior or the frequency of activity (Kreeger et al. 1996), so the exhibit size at the Great Plains Zoo would not affect the red wolves' behaviors. In summer 2012, an adult male and an adult female red wolf were directly observed (Table 1, Figure 2). Their behaviors included interaction with their 3 pups born that spring. Their breeding status was not known before the start of the study. Observations took place during the zoo's summer visitor hours (900 h to 1900 h), from May to August. I trained technicians in use of the designed ethogram, canine behaviors, and observational techniques for uniform behavioral data collection. The time of day and the amount of time the observation took place was recorded (Bernal

and Packard 1997). Observers sat quietly outside the exhibit before observations were initiated to acclimate the wolves to their presence. Behaviors were recorded continuously ensuring no rare behaviors were missed, and no particular behavior seemed prevalent due to timing (Bernal and Packard 1997, Pirfarre and Valdez 2012). Each individual red wolf was available for observation during sessions.

Behaviors observed were categorized into active and resting behaviors in an ethogram (Table 1, Figure 2). Territory marking was described as the red wolf marking specific spots of the exhibit with a lifted leg to apply urine onto objects or defecation (Patent 1990, Mech 1991). Females also will raise their leg to urine-mark territory (Mech 1991). Submission/anxiety was displayed as ears and tail tucked back with a closed mouth (Nowak et al. 1987, Patent 1990, Mech 1991).

Pacing, a stereotypical behavior of stressed carnivores in captivity, was noted (Clubb and Mason 2007). Curiosity was indicated by the wolf investigating either an area of their enclosure or enrichment by sniffing or pawing it (Carlstead 2009). Play among individuals in a wolf pack is very important for safe competition between adults, coordinating pack behaviors, and honing of life skills (Cordoni 2009). If any behavior that was not already described in the ethogram occurred, it was recorded as 'OTH*'.

The resting behaviors recorded include: sleeping, relaxed state, and not visible. When a red wolf was sitting, standing with no movement in a relaxed posture, lying down, or had no abrupt activity as described above in active behaviors, it was considered resting. A loose hanging tail indicates no stress and that a wolf is relaxed (Nowak et al.

1987). When the wolves were not visible to observe their behaviors, a behavior of 'not visible' was marked.

The duration of zoo visitors was recorded continuously, including a beginning and end time of visitors' presence (Pifarre and Valdez 2012). Behaviors during visitations were compared using the frequency of desirable/acceptable versus undesirable behaviors when visited to determine the effect of human visitation on the red wolves' behaviors. Undesirable behaviors when visitors were present were: not visible, alert, submission/anxiety, and pacing. All other behaviors included on the ethogram were considered to be desirable (Table 1). The Activity frequency (Af) of the individual red wolves' undesirable versus desirable behaviors for objective 2 was compared to visitor's presence using Chi-square Goodness of Fit test with Yates' continuity correction.

The behavioral data collected were based on grey wolf, Mexican wolf (*C. lupus baileyi*), maned wolf (*C. brachyurus*), and red wolf behaviors (Mech 1991, Kreeger *et* al. 1996, Bernal and Packard 1997, Carlstead 2009). An Activity Index (Ai) was used to determine the amount of time the wolves were active over the total time they were observed (Bernal and Packard 1997, Calvet et al. 2009). Active behaviors were combined and converted into a percentage. The Ai describes how much each red wolf spent active, and was then divided into specific behaviors. The Activity Frequency was used to determine the frequencies of each behavior per individual (Bernal and Packard 1997, Pifarre et al. 2012). Objective 1's data were analyzed as observational data including Ai and Af.

$$\text{Ai} = \frac{\text{Active behavior time}}{\text{total time}} \text{ x } 100\%$$

$$\text{Af} = \frac{\text{Behavior } \beta * \text{ time}}{\text{total time}} \text{ x } 100\%$$

* β is a specific behavior.

In summer 2013, continuous behavior observations were made of 1 juvenile female, 1 juvenile male, and the same adult female red wolf from 2012. Data were collected based on the ethogram from 900 h to 1900 h, along with visitors' presences as in the previous summer. The ethogram included active and resting behaviors for the red wolves (Table 1). In addition to continuous behavioral observations, enrichments were added once per week to the red wolves' enclosure (Table 2). I observed all enrichment behaviors to reduce observer bias. The enrichments were chosen based on the AZA's large canid care manual to promote appropriate behaviors from physical objects, food, scents, and sounds (AZA Canid TAG 2012). Enrichments were chosen from 4 categories: auditory, olfactory, feeding, environment. Auditory enrichments were recordings of other red wolves howling (USFWS 2012), ocean waves with gull calls, and continuous frog calls. Sounds similar to the species' natural habitat can be more stimulating than other sounds (Wells 2009). Olfactory enrichments used were hay bedding from rhino and hoof stock exhibits, ground cloves, and dill weed. Scents from prey species have also shown increased activity in many species (Wells 2009). Feeding enrichments were frozen blocks of animal blood, peanut butter, and whole deer legs. Environment enrichments were large tree logs, caribou antlers, water in the pond, and large barrels cut and filled with sand.

Objective 3's data were observational data including Ai, and use frequency of each enrichment type.

RESULTS

ACTIVITY

There was a total of 405 hours of observations with 138 hours in 2012 and 267 hours in 2013. In 2012, the adult male was active 16.4% of the time, and the adult female was active 25.9% of the time. The adult female was most active in July (38.4% of the time) (Figure 2). Her predominant behavior in July was 'locomotion', moving around their exhibit. The adult female spent the majority of her time 'not visible' in May, June, and August (Appendix 1-4). The adult male was most active in May (19.4% active behaviors) and decreased activity over summer (Figure 2). His predominant behavior was 'relaxed' throughout summer 2012 (Appendix 5-8). In 2013, the adult female was active 16.6% of the time with her predominant behavior was 'not visible' throughout summer 2013 (Appendix 9-12). The juvenile male was active 14.6% of the time, and the juvenile female was active 25.6% of the time in 2013. The adult female was most active in May (25.2%) and less active as summer progressed (Figure 3). The juvenile male was also most active in May (21.7%). His predominant behavior was 'not visible' like the adult female (Appendix 13-16). The juvenile female was most active in May (36.6%) in 2013 (Figure 3). Her predominant behavior was 'relaxed state', but August was predominantly 'not visible' (Appendix 17-20).

VISITORS

Visitors were present for 206 hours total with 58 hours in 2012 and 148 hours in 2013. Visitors were present at the red wolf exhibit for 42.0% of the time observed in 2012 and 55.5% of the time observed in 2013. In 2012, the adult male exhibited undesirable behaviors 20.0% of the time, but these behaviors decreased as summer progressed. He decreased undesirable behaviors each month from 30.8% in May to 2.7% in August. The adult male's difference in desirable and undesirable behaviors when visitors are present was significant, Chi-sq. = 47.0, $p < 0.001$. The adult female exhibited undesirable behaviors 49.4% of the time when visitors were present in 2012 and 48.6% of the time when visitors were present in 2013. There was a significant difference in desirable versus undesirable behaviors when visitors were present for the adult female, Chi-sq. = 395.0, $p < 0.001$ (Figure 4-5).

In 2013, both the adult female and juvenile male increased their undesirable behaviors from May to July. The adult female and juvenile male had a decrease in undesirable behaviors in August from the increasing pattern though out the previous months. July had the highest values of undesirable behaviors for the adult female and juvenile male. The juvenile female increased from 22% in May to 38% in August with a difference in desirable versus undesirable behaviors when visitors were present, Chi-sq. = 27.6, $p < 0.001$. The juvenile male exhibited undesirable behaviors 36.2% of the time and the juvenile female 26.3% of the time (Figure 5). The juvenile male also showed a difference between desirable and undesirable behaviors when visitors were present, Chi-sq. = 146.0, $p < 0.001$. After looking at each individual red wolf's response to visitors,

collectively their Activity frequencies also had a significant difference in desirable versus undesirable behaviors when visitors were present, Chi-sq. = 476.0, $p < 0.001$.

ENRICHMENTS

In 2013, the auditory and environmental enrichments were most beneficial for the adult female and young female to eliciting active behaviors, while the olfactory and feeding enrichments were most beneficial for the young male to elicit active behaviors (Table 3, Figure 6-9). Auditory enrichments were the most difficult to administer and least successful at causing desired behaviors (Figure 7). All other enrichment categories had several desirable behavior frequencies, except for peanut butter in the feeding category & frog calls in the auditory category (Figure 6-7). Auditory and feeding enrichments created the highest frequencies of desirable, active behaviors (Table 3, Figure 6-7). Auditory enrichments were the most successful followed by feeding, olfactory, and environmental enrichments (Figure 6-9). When behaviors of all red wolves were examined, the average interaction time for environmental enrichments were 13.4%, feeding enrichments were 21.3%, olfactory enrichments were 13.7%, and auditory enrichments were 36.5% (Table 4).

DISCUSSION

ACTIVITY

The adult male was active 16.4% of the time in 2012. This is similar to the time the adult female spent active in 2013 when she had no pups to raise. The adult male was most active in May at 19.4% when the weather was cooler. His pups were still young, approximately 1-month old, and he spent more time ‘alert’ in May than any other month.

The adult male's time spent 'relaxed' and 'sleeping' increased as the summer progressed. His overall monthly activity gradually decreased. His 'other' activity was the largest in August; his 'other' behavioral time was hunting wild birds and rabbits in the exhibit. The 3 approximately 4-month old pups mimicked this hunting behavior without his success. This parental behavior is important for the pups' development of survival skills such as hunting. If these pups were to be released into a refuge, they would have skills to obtain food and hopefully, ultimately survive to breed. Overall, the adult male could be seen 'relaxing' 40.5% of his time.

The adult female decreased overall activity from 25.9% in 2012 to 16.6% in 2013 summers. In 2012, she had given birth to 3 pups in April. In the beginning of 2012, the adult female was less active in May, 15.3%, compared to June through August. In May 2012, she spent 75.7% of her time 'not visible' in the den with her one month old pups. In June and July, the adult female was more active moving about the exhibit. She spent less time 'not visible' in the den and more time interacting with her pups. The pups aged, became less dependent on her for milk, and demanded more social learning activity from her. The pups were completely weaned from their mother, the adult female, and more socially independent than before, so she could spend more time relaxing and escaping the heat than actively engaged in rearing her pups. Overall, the adult female was more active than the adult male.

In 2013, the adult female was most active 25.2% in May, unlike in 2012 when she was the less active due to her young pups keeping her more inactive resting or not visible in the den. May was a cooler, less humid month; the adult female spent more time moving about the exhibit, being curious, and playing with her juvenile pups than the rest

of the summer months. Her activity decreased gradually as she spent more time ‘not visible’ as the summer progressed.

In 2013, the juvenile male was active 14.6% of the time, and the juvenile female was active 25.6% of the time. The juvenile female was the most active red wolf while the juvenile male, her brother, was the least active in 2013. The juvenile red wolves spent the most time ‘playing’ in May than the rest of the summer. The juvenile male’s activity decreased as the summer progressed like the adult female’s activity. The juvenile female’s activity slightly decreased as the summer progressed, but in August, she increased her activity back to the June activity percentage. The juvenile female’s ‘other’ behaviors included hunting wild birds and rabbits, and splashing and wading in the exhibit’s pool. While the juvenile female was hunting within the exhibit, the juvenile male would assist her, but he did not initiate stalks on prey near the amount she did.

VISITOR INTERACTIONS

Red wolves at the Great Plains Zoo, Sioux Falls, SD, had a regular keeper and 2 substitutes who assisted with care. With the small number of regular keepers who had positive interactions including feeding the wolves, their HAR would be seen as positive (Hosey 2008). Maned wolves have been seen to decrease their fear of their keeper if human-raised. However, if a keeper creates noise or sudden movement near a maned wolf, they became anxious and even aggressive (Carlstead 2009). The red wolves were not keeper raised, but they had frequent, non-contact interaction with their keepers such as feedings and exhibit cleaning. When red wolves saw their keepers, they displayed excited behaviors which were not observed with any other humans.

During the observations, observers had no direct contact with red wolves. Regular, quiet presence of observers became neutral HAR (Hosey 2008). The red wolves would continue their desirable behaviors in front of observers, including some unique experiences such as group howling. However, when visitors came to the exhibit, red wolves' undesirable behavior frequencies increased significantly based on Chi-square statistical testing. The large and naturalistic exhibit the red wolves lived in allowed them to seclude themselves from visitors to relieve possible anxiety (Hosey 2000). The adult female frequently secluded herself from view when visitors were present. At times, the family group would stop socializing and be alert to visitors. Previous literature has supported the stressful effect of unfamiliar humans (visitors) on zoo animals (Hosey 2008). Visitors were present for short, irregular periods, and their interactions can be generalized into one group of unfamiliar humans by the red wolves (Hosey 2008). Each red wolf had a significant difference, Chi-sq. =47, 395, 27.6, 146; $p < 0.001$, between desirable and undesirable behaviors when visitors were present in both 2012 and 2013. With the large number of summer visitors, there were some negative interactions with the wolves. Visitors screamed, created other loud noises, and threw objects at the red wolves in an attempt to elicit a behavior. With the increase in undesirable behaviors by the red wolves when visitors were present and the negative interactions from some visitors, their HAR would be negative (Hosey 2008).

The adult female spent over half of the time when visitors were present in an undesirable behavior in May 2012. She had given birth in April to 3 pups, and the pups were starting to explore the enclosure. It would be common for a mother red wolf to be alert, anxious, and not visible, hiding her pups when people were present. The adult male

in 2012 spent roughly a third of his time in May and June 2012 presenting undesirable behaviors when visitors were present.

ENRICHMENTS

The auditory enrichment of ocean sounds was the most successful at eliciting desirable behaviors from red wolves. The ocean sounds elicited 100% and 96.3% desirable behaviors from 2 red wolves while the other auditory enrichments elicited very little or no response. I recommend using habitat-type sounds (the ocean) since it received the highest response to further determine auditory enrichment effectiveness on red wolves. Auditory enrichments can be affected by animals' ability to distinguish it from other sounds present at the same time. Wind, loud visitors, or other factors such as construction or traffic can inhibit auditory enrichment. Sounds can be an enrichment that a zookeeper can use to determine if there is an immediate effect. A variety of enrichments is important to minimize habituation or extinction of eliciting a response to enrichments. Auditory enrichment is cost and time effective enrichment for captive facilities to incorporate. During a busy animal husbandry routine, a keeper can simply play a recording on a speaker for a few minutes while cleaning or feeding before leaving the exhibit and extinguishing the sound. More research into auditory enrichments is needed to determine if there is a behavioral extinction time frame and which types are most successful.

With the exception of peanut butter, feeding enrichments were widely used by the red wolves. I do not recommend using peanut butter as a feeding enrichment even though the accepted theory is that canines readily enjoy peanut butter (Miller 2012). I

recommend using the bloodsicle which emulates the red wolves' meat diet. Differentiating the presentation of their daily diets can be a quick and easy feeding enrichment. I recommend scattering their daily diet around the exhibit or putting their diet in locations not previously used. The unaltered, whole deer legs with fur and hooves were highly interactive. Besides being a food source, the fact that deer are a prey animal for the red wolf increased desirable activities. Other feeding enrichments of natural prey could include rodents which are commercially available since nutria (*Myocastor coypus*) is a large prey source for wild red wolves. Keepers already spend time preparing diets that are previously paid for by the facilities for the red wolves. Altering that diet to add bloodsicles or frozen rodents would be relatively easy for keepers with little to no added cost.

Olfactory and environmental enrichments created the highest amounts of desirable, active behaviors from all the red wolves. Natural scents, such as cloves and prey-like species' odors, were highly interactive with the red wolves. I recommend the cloves and Hoofstock waste hay enrichments due to their natural origin, especially important for this re-introductive species. Cloves were an affordable and easily acquired scent that could be detected over other zoo related scents. Waste, such as doe urine or hoof stock feces could be a good olfactory enrichment for red wolves suggesting the presence of a prey species. Zoos and other captive centers can repurpose and reuse other animals' wastes including other predators to reduce cost and increase productivity and variety in olfactory enrichments (AZA Canid TAG 2012). Other scents in accordance to the AZA's large canid care manual that could be used to elicit behavioral responses from the red wolves are peppermint, rosemary, sage, cinnamon, and chamomile (AZA Canid

TAG 2012). Chamomile has been shown to have calming effects on dogs resulting in more relaxation and less stress related behaviors such as excessive barking (Graham et al. 2005). Peppermint and rosemary has been found to increase physical movement, while peppermint also increases mental stimulation in dogs and other animals (Graham et al. 2005). Due to the high usage of the cloves and dill weed, the use of cinnamon, peppermint and sage, other highly potent scents, is also recommended. Due to the stressful HAR visitors can cause, the use of chamomile is also recommended.

Environmental enrichments allowed for several different behavioral responses from the red wolves such as territory marking, walking/running, curiosity, play, and other behaviors. Environmental enrichments were very physically interactive. After red wolves visually surveyed the new object/substrate in their exhibit, they would mark it with urine. Even if another individual had already marked the enrichment, other red wolves would continue to mark the enrichment. Their curiosity peaked as they would paw, chew or investigate further as to what the enrichment was.

The large log was continuously marked by the red wolves. The wolves would stop by the log throughout the day to reexamine it by sniffing, pawing, and then remarking it. The juvenile female even spent time trying to move the large log. The red wolves ran around the exhibit dragging caribou antlers to new spots. The sandbox enrichment initiated a lot of curiosity including sniffing the barrels and then continuous digging in the sand. The individual red wolves would dig in one sandbox, then go to another sandbox, sniff it and then continue digging in the sand. This behavior continued in a random pattern of which sandbox was investigated next by each individual. I recommend the sandbox or something similar. The juvenile female spent 96.5% of her time

interacting with the sandbox while it was present. The use of a pool did not only provide an alternate water source and substrate to cool down from the summer heat, it allowed the red wolves to interact differently in their environment by wading through the water. Behaviors associated with the pool enrichment included territory marking, eating/drinking, and other behaviors.

CONCLUSIONS

Red wolves should have a natural fear of humans while in captivity (Mech 1970, Patent 1990). As the number of visitors increase, an animal often paces, retreats from view, increases aggression, or shows other undesirable behaviors (Morgan and Tromborg 2007, Fernandez et al. 2009). All of the red wolves in the study displayed a negative behavior in response to visitors. Visitors and red wolves had a negative HAR, while the keepers and red wolves had a positive HAR. With red wolves being in the SSP as an endangered animal, keeping red wolves off display during attempted breeding and pup rearing would be beneficial for the red wolves positive, active behavior and continued species' survival.

Mixing feeding and/or olfactory categories with environmental enrichments would be a quick and easy way to change enrichments for zookeepers with limited time or resources to decrease extinction or habituation behavior in the red wolves. If a keeper notices a repetitive, undesirable behavior, enrichment should be chosen to extinguish said behavior. If a chosen enrichment does not extinguish said behavior, then a new enrichment or mixture should be used. The animal should also have the opportunity to interact or not interact with the enrichment base on its individual preference (Mason et al.

2007). Environmental enrichments are also a good way for the public to get involved. Many zoos have an "Animal Enrichment Day" where the public has the chance to view most of the animals getting a large, usually environmental or feeding enrichment. The Great Plains Zoo even allows volunteers the opportunity to create the enrichment for further involvement. This involvement goes back to the zoos' mission for increased awareness of conservation and empathy towards wild and endangered animals. This also is an opportunity for increased revenue for the facility. I recommend other facilities prompt the public for enrichment ideas like "Animal Enrichment Day" to get new enrichment ideas.

Limitations for this study include time, amount of resources including red wolves and participating facilities. Observations could only take place during the summer seasons, but that is the busiest time for visitors. Summer has the highest volume of visitors making it the best time to compare the effects of visitors on red wolves. Only 4 red wolves were in the study, with the adult male leaving for another facility before the next observational year. This was uncontrollable as he was paired with another female for breeding. Most facilities do not have the time or resources for their staff to do direct observations for this amount of time or use staff time to collect these data in lieu of caring for the animals. I sent out a confidential survey to 31 red wolf SSP facilities with 4 responding at the time of this thesis about enrichments, ethograms, and the new red wolf recovery plan.

My study is a long term observational study where most facilities are lucky if a staff member can observe the wolves for 1 day continuously. The facilities that responded to the survey indicated that they do not have the staff or intern resources to care for the

red wolves and complete a behavioral study using an ethogram. If they have tried behavioral observation, an ethogram was not used. Another study needs to be done on red wolves in captivity year round and for more years. This would reduce the seasonal and temperature differences between behavior and visitation numbers. More studies of the same nature, using the same designed ethogram are needed to start a baseline behavioral Ai and Af for different red wolf SSP facilities. Each facility using a different ethogram would create issues when trying to compare Ai's and Af's for different wolves at different facilities. I recommend other red wolf SPP facilities work together to create a standard, red wolf ethogram, not a gray wolf ethogram, so more inter-facility discussion can happen. A study looking at all the facilities using the same ethogram, and possibly the same enrichments, would be ideal. The facilities that responded had mixed reactions to using the red wolf ethogram I developed. Answers ranged from yes, no, and already have their own designed ethogram in use. With the red wolf survival plan being rewritten currently, a large change is moving wild red wolves back into captivity (Miranda 2016). If each captive facility is using a different ethogram, their observations would not be easily compared for future captive management of this species.

I also recommend another study over several years observing more enrichments within each type, and observing again the enrichments used in this study. This would be beneficial for red wolves in captivity. Out of the facilities that responded to the survey, enrichments such as sand and mulch substrates, newspaper, duck decoys, carcasses, and beef and chicken feedings are their red wolves' highest Ai enrichments. A sand substrate and deer legs were used in this study that mimic another facilities' sand substrate use and carcass feeding. Only 1 facility had an enrichment that they have since stopped using

which was essential oils. A possible extinction time could be revealed for certain enrichments or a better enrichment manual written based on direct observations and animal use across facilities. With more red wolves possibly returning to or being put in captivity for the first time, enrichments will become extremely important for the retention of wild and active behaviors.

There was also a mixed reaction to the new red wolf survival plan proposed by the USFWS. The facilities either had concern about moving wild red wolves into captivity, no concern, or thought more time was needed to decide the implications. The Wolf Conservation Center, Red Wolf Coalition, Center for Biological Diversity, and National Wildlife Federation, to name a few, have been public with their opposition of the new red wolf recovery plan. These organizations have sent emails to red wolf supporters, myself included, to sign petitions, write to your elected officials, and USFWS directors opposing the new recovery plan. These organizations have also taken to social media such as Facebook and Twitter to get their messages out to red wolf supporters. The Center for Biological Diversity filed a notice of intent to sue the USFWS in March 2016 over the new recovery plan (Adkins and Santarsiere 2016). With these polarizing views between the USFWS, conversation organizations, and many of the public population's red wolf supporters, captive studies need to continue. Studies such as this one and previously recommended ones will become more important if the red wolf population is to become a majority captive population.

Table 1. Ethogram of described red wolf behaviors displayed at the Great Plains Zoo, Sioux Falls, South Dakota in 2012-2013. The most common behaviors displayed in captivity were described. Behaviors are described as mutually exclusive. † indicates resting behaviors. U= undesirable behavior. D= desirable behavior.

Code	Behavior	U/D	Description
ALT	Alert state	U	Standing on all fours, stationary with head and ears upright with its eyes fixed on something.
PAC	Pacing	U	Walking or running in a pattern with no function for more than 1 lap or overlap of the pattern.
SUB	Submission/Anxiety	U	Ears and tail tucked back with a closed mouth, accompanied by crouched legs.
NV†	Not Visible	U	Out of view from observer.
SLP†	Sleeping	D	Lying down with eyes closed, and no movement for ≥one minute.
RLX†	Relaxed state	D	Has a loose hanging tail, relaxed ears, either sitting, lying down, or standing with no movement. Can be accompanied by an open mouth with tongue out and ears forward.
ED	Eating/Drinking	D	Drinking or in the process of putting food in its mouth.
LOC	Walking/Running	D	Walking or running for more than four steps.
PLY	Play	D	Interacting (contact or not) with others by chasing, tumbles, or jumping at/on another wolf or object.
CUR	Curiosity	D	Taking interest in an object by sniffing or pawing at.
AGR	Aggression	D	(Contact or not) Biting, growling or pinning down other wolf. Includes baring teeth.
GRM	Grooming	D	Licking, biting, or scratching to groom.
TER	Territory Marking	D	Marking spot with urine, feces or specialized glands.
KEP	Keeper present	D	Zoo keeper is present causing the wolf to jump, run, and act unusually excited. May even jump on fence towards keeper.
PUP	Pup Interaction	D	Interacting with its pups (contact or not) by sniffing, licking, feeding, playing with, lying with, etc.
OTH*	Other*	D	Any other behavior not previously described. *Note other behavior.

Table 2. Enrichment categories with the selected enrichments within each category for behavior enhancement of red wolves at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2013.

AUDITORY*	**OLFACTORY**	**FEEDING****	**ENVIRONMENT**
Frog Calls	Zebra/Giraffe hay	Bloodsicles	Large cut barrels with sand substrate
Red wolves howling	Ground cloves	Deer legs	Water in their pond
Ocean waves with gulls	Dill weed	Peanut butter on objects	Large tree logs and reindeer antlers
*recordings		**hidden and/or randomly placed in exhibit	

Table 3. Time each individual red wolf spent interacting with enrichments when it was presented at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2013.

		Adult Female (%)	Male Pup (%)	Female Pup (%)
Feeding Enrichment	Peanut Butter	0	0.19	0.01
	Bloodsicle	1.17	3.25	17.2
	Deer leg	1.97	65.9	38.2
Olfactory Enrichment	Cloves	2.61	2.06	5.26
	Dill weed	1.24	12.6	4.66
	Hoofstock Scented Hay	1.65	6.68	4.70
Environment Enrichment	Sandbox	2.80	7.63	96.5
	Pool	0.30	1.07	1.74
	Antlers & Log	2.69	1.74	12.0
Auditory Enrichment	Ocean	100	23.0	96.3
	Frog Calls	0	0	0
	Wolf Howls	0	12.18	3.68

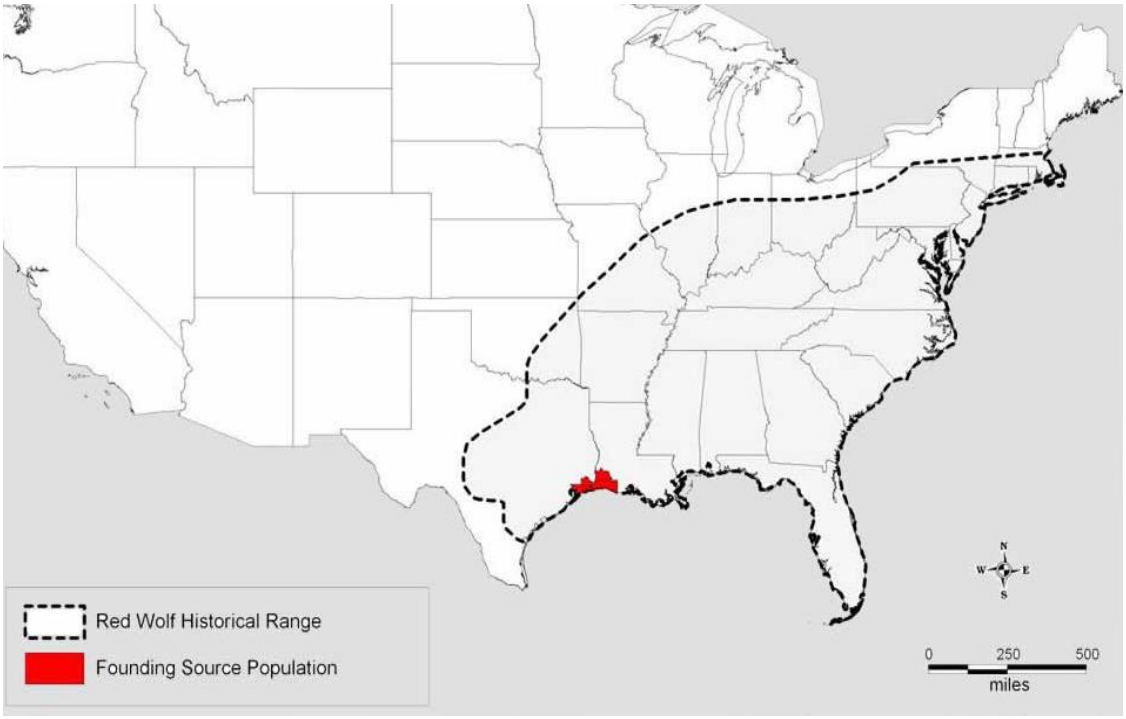

Figure 1. Historical range of the red wolf. The founding source population of 14 red wolves was taken from the area shaded in red (From USFWS 2014).

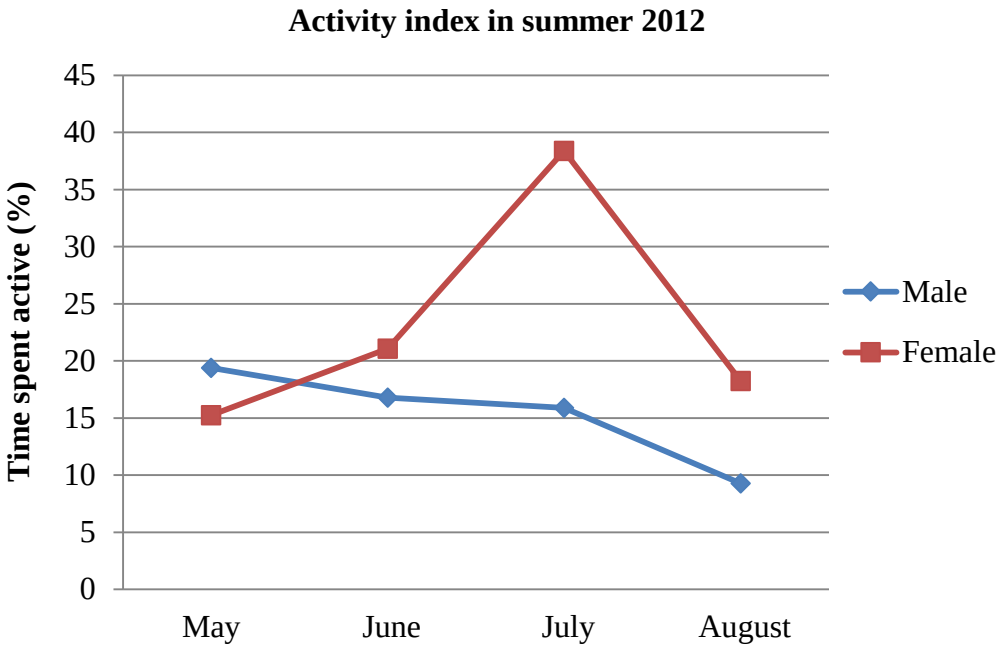

Figure 2. Adult male and female red wolves' time spent active monthly at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2012.

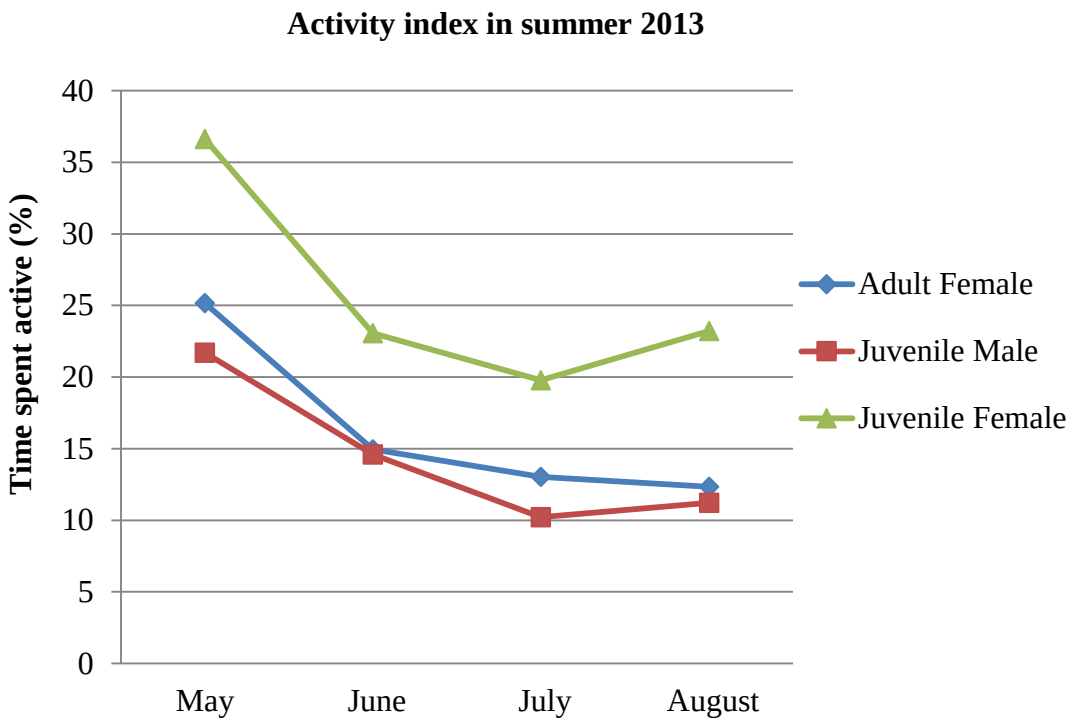

Figure 3. Adult female, juvenile male and female red wolves' time spent active monthly at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2013.

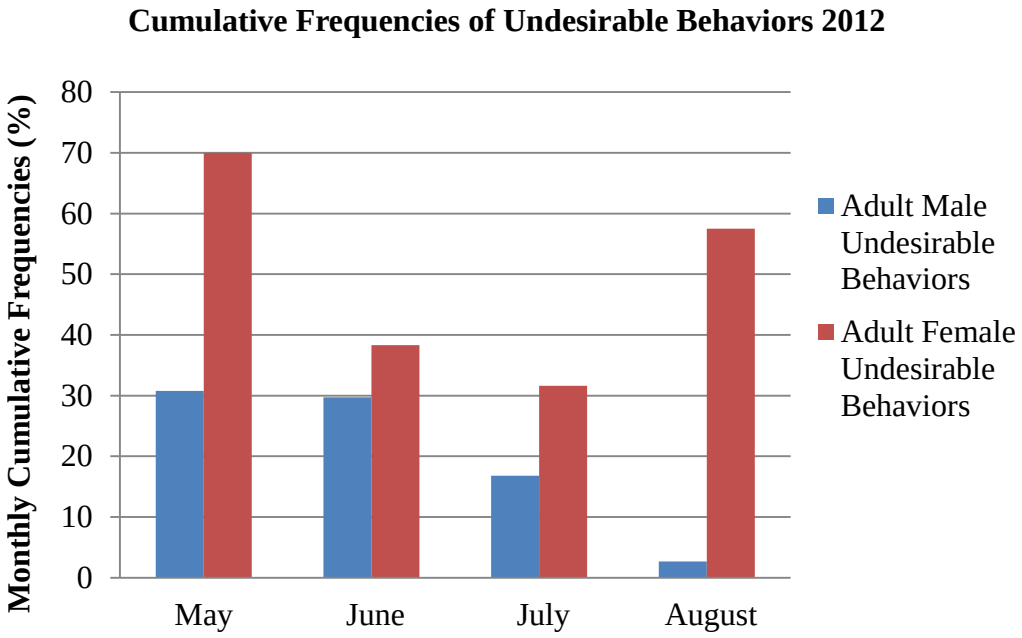

Figure 4. Monthly frequencies of undesirable behaviors exhibited by adult male and adult female red wolf when visitors were present at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2012.

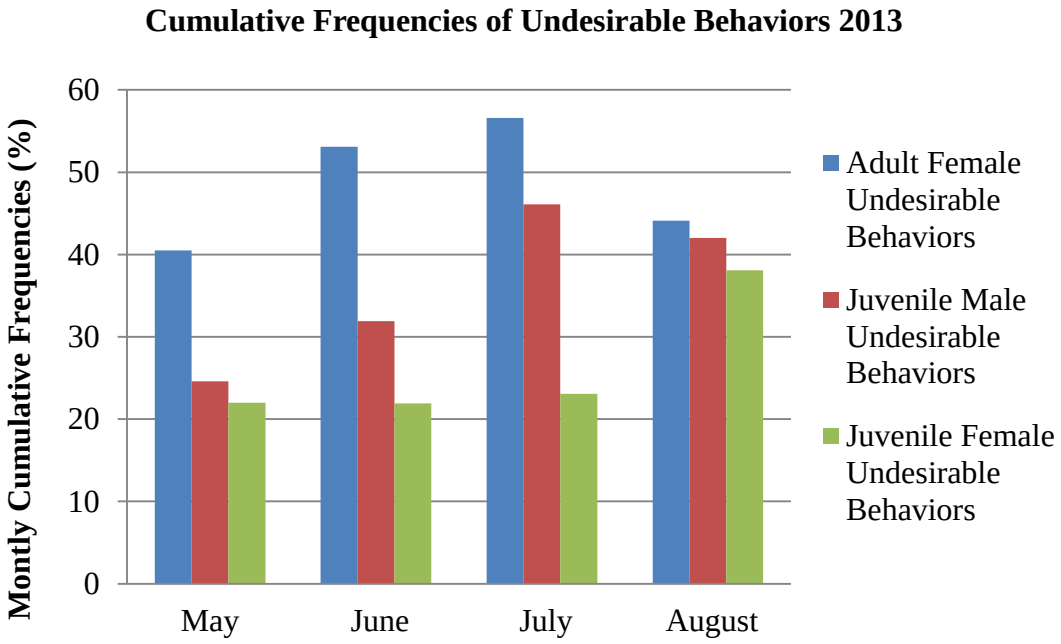

Figure 5. Monthly frequencies of undesirable behaviors exhibited by adult female, juvenile male, and juvenile female red wolf when visitors were present at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2013.

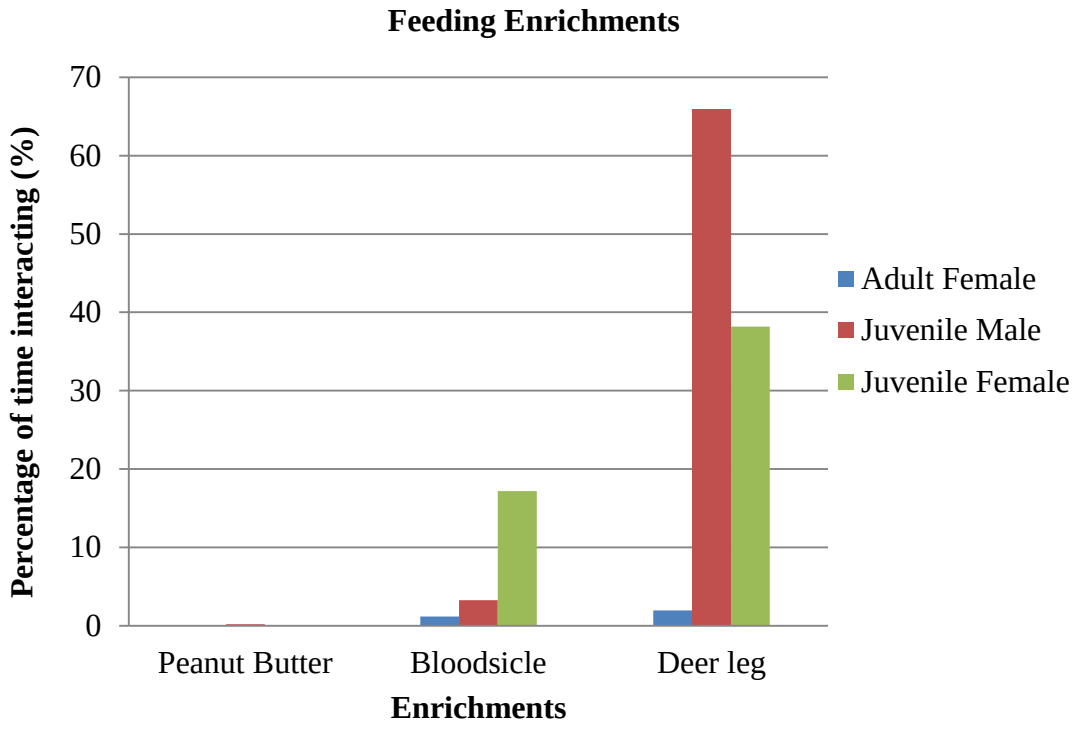

Figure 6. Percentage of each individual red wolf's time interacting with feeding enrichments at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2013.

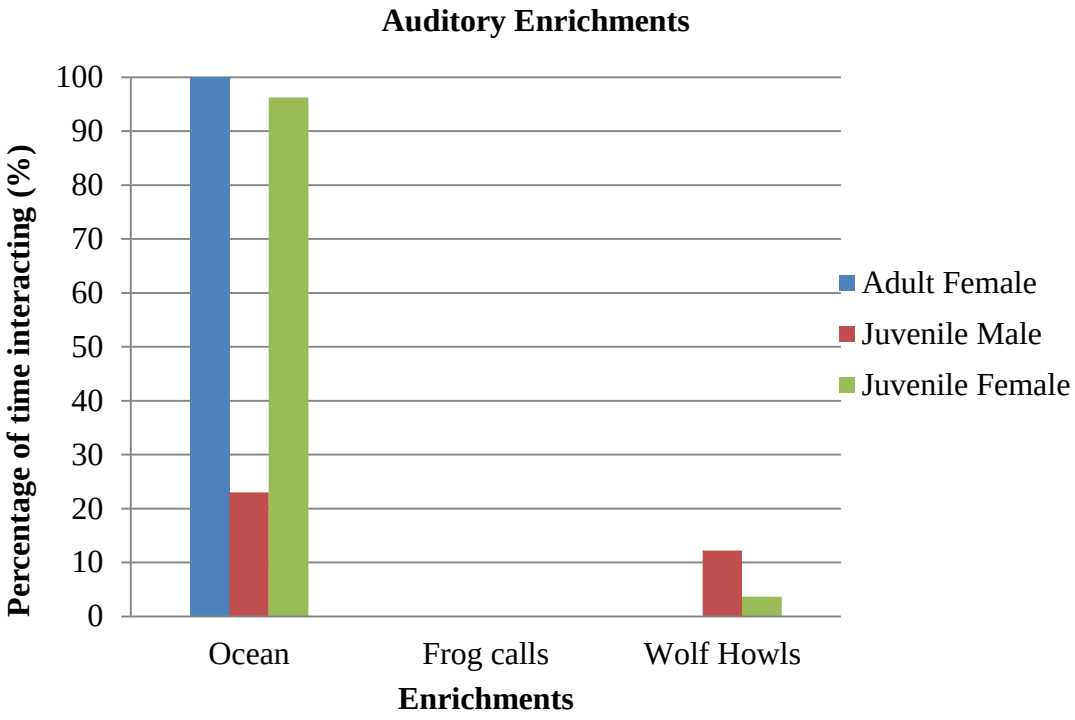

Figure 7. Percentage of each individual red wolf's time interacting with auditory enrichments at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2013.

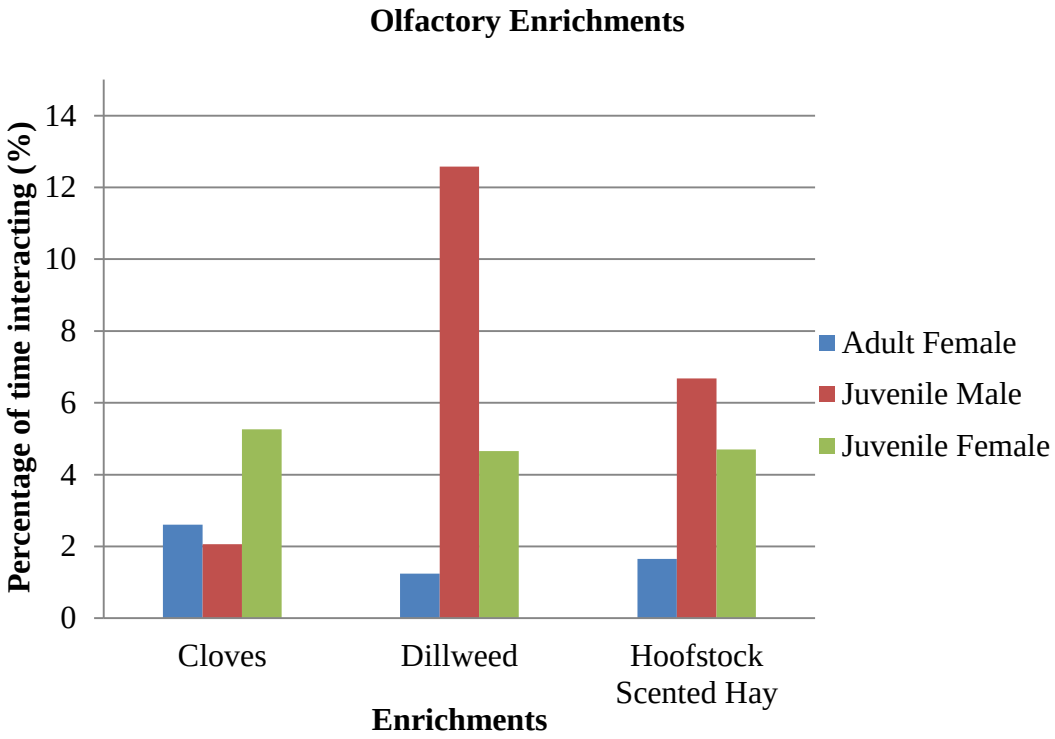

Figure 8. Percentage of each individual red wolf's time interacting with olfactory enrichments at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2013.

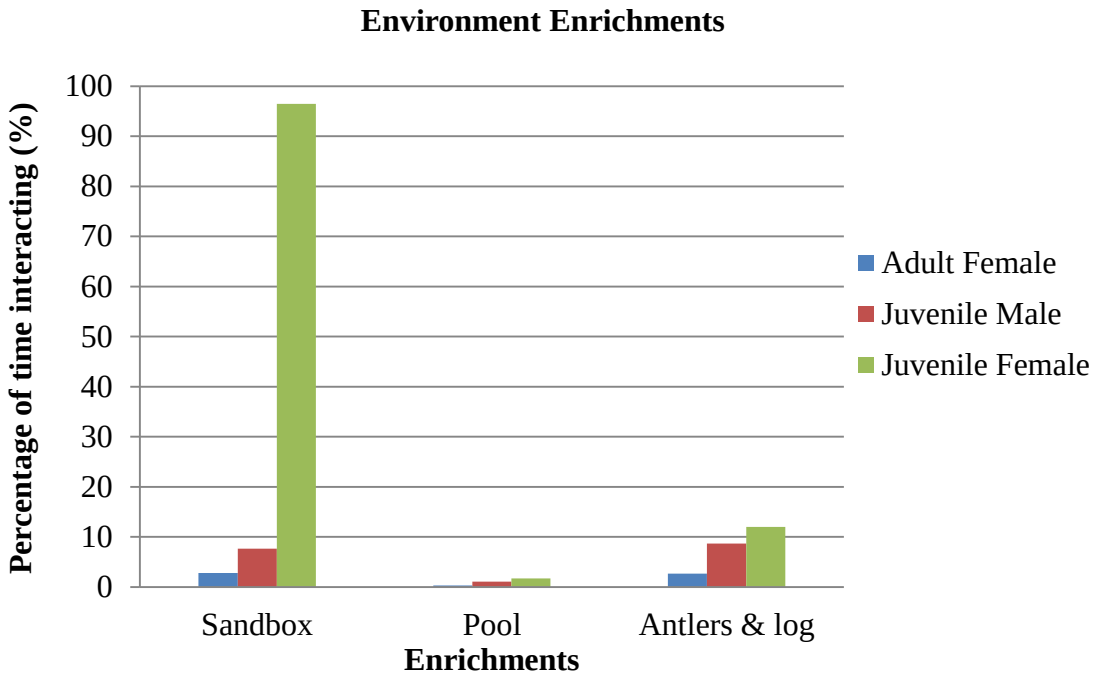

Figure 9. Percentage of each individual red wolf's time interacting with environment enrichments at the Great Plains Zoo, Sioux Falls, South Dakota, in summer 2013.

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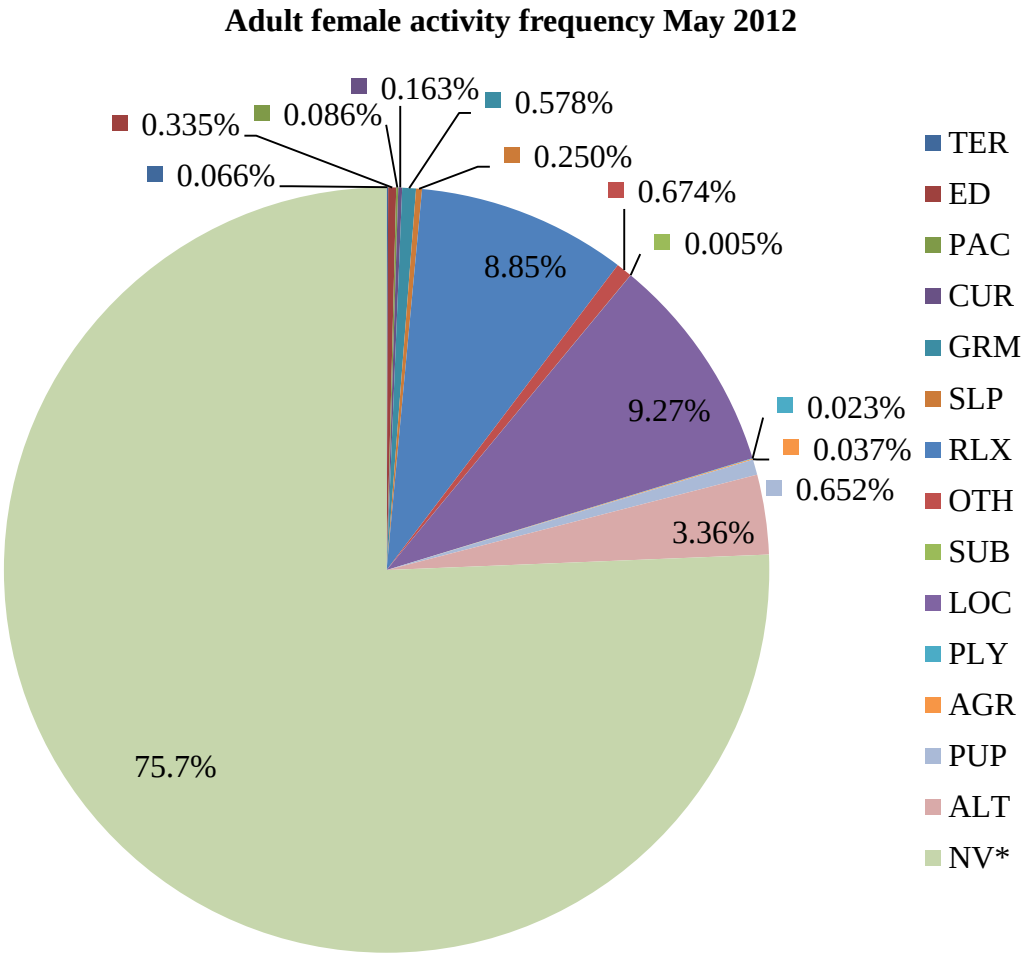
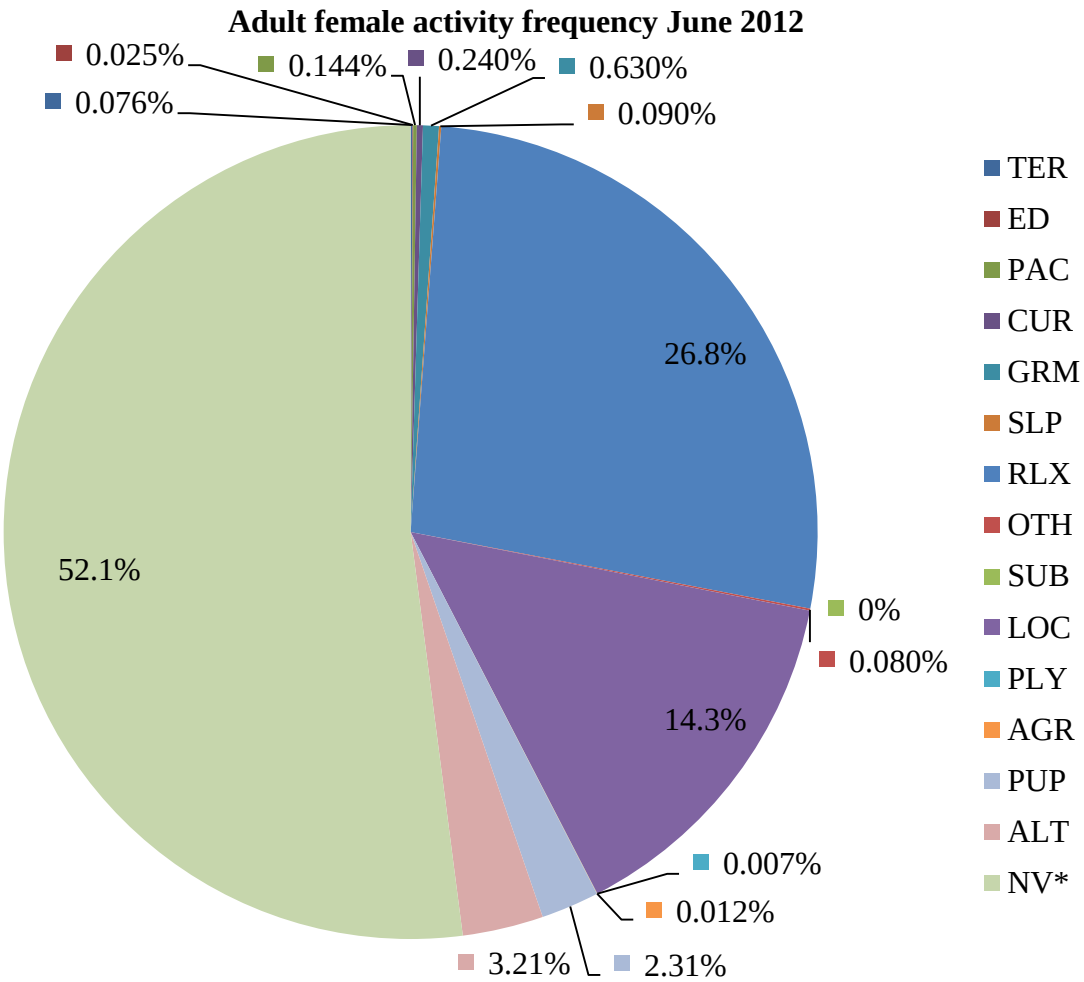
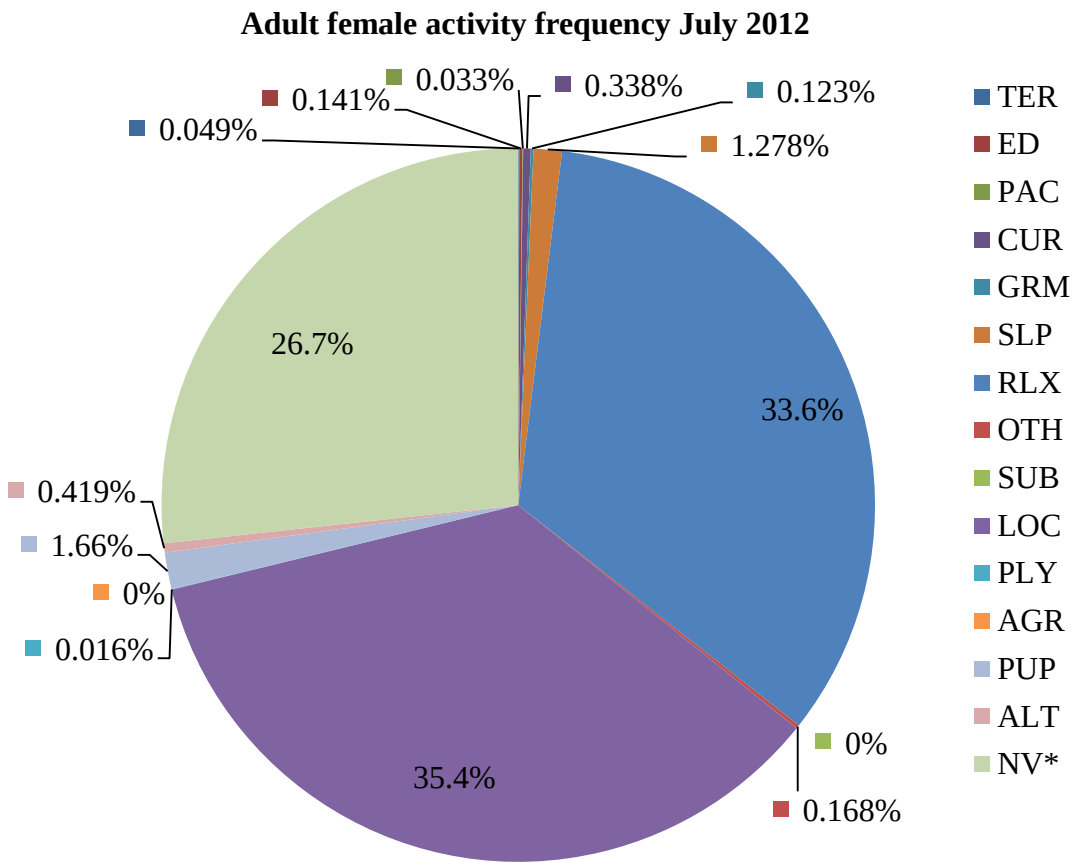
APPENDIX



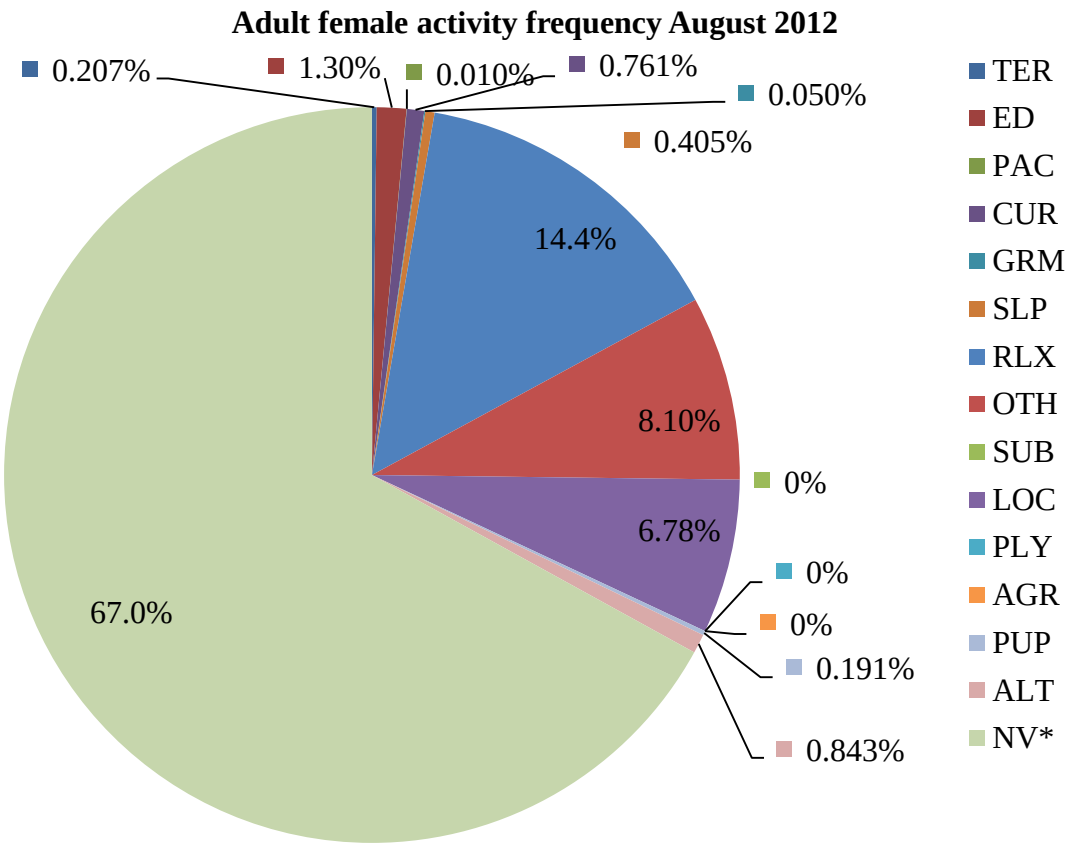
Appendix 1. Adult female red wolf time spent active in May 2012 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, PUP: interaction with pups, ALT: alert state, NV: not visible to observer.



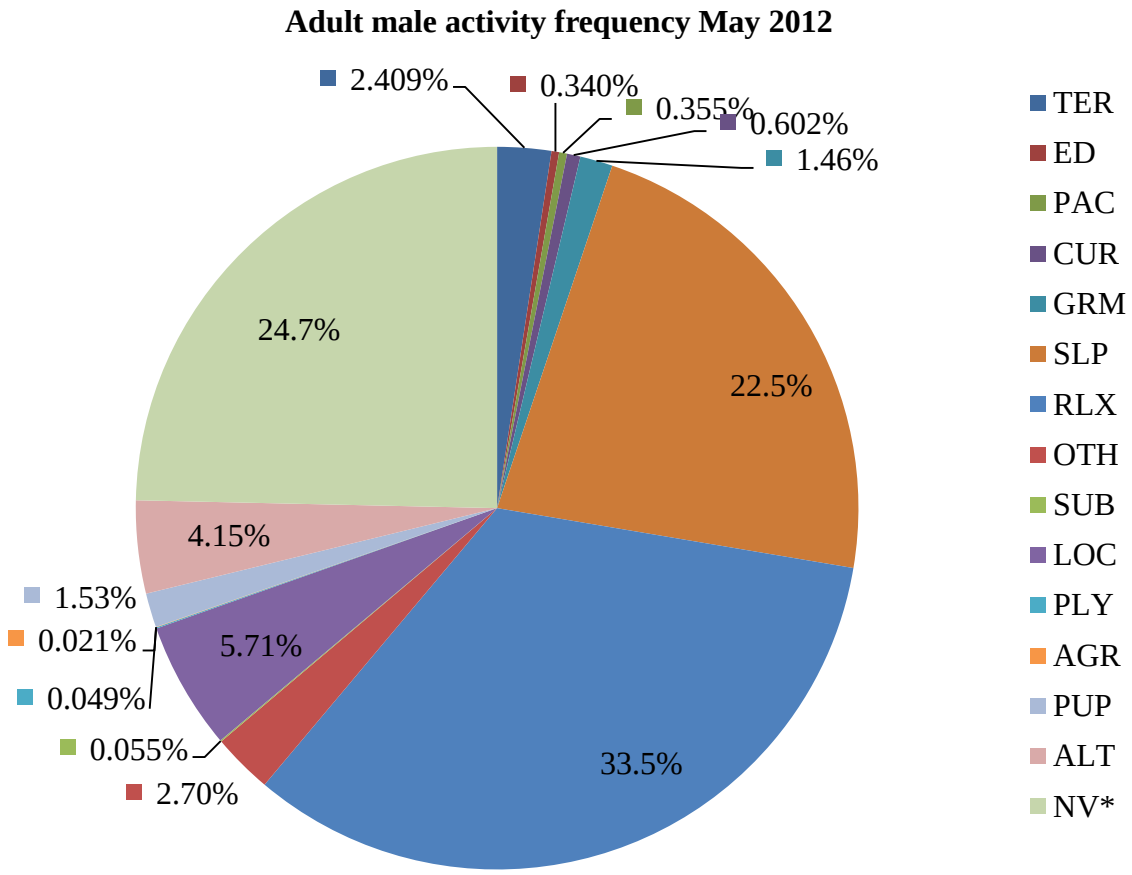
Appendix 2. Adult female red wolf time spent active in June 2012 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, PUP: interaction with pups, ALT: alert state, NV: not visible to observer.



Appendix 3. Adult female red wolf time spent active in July 2012 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, PUP: interaction with pups, ALT: alert state, NV: not visible to observer.



Appendix 4. Adult female red wolf time spent active in August 2012 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, PUP: interaction with pups, ALT: alert state, NV: not visible to observer.



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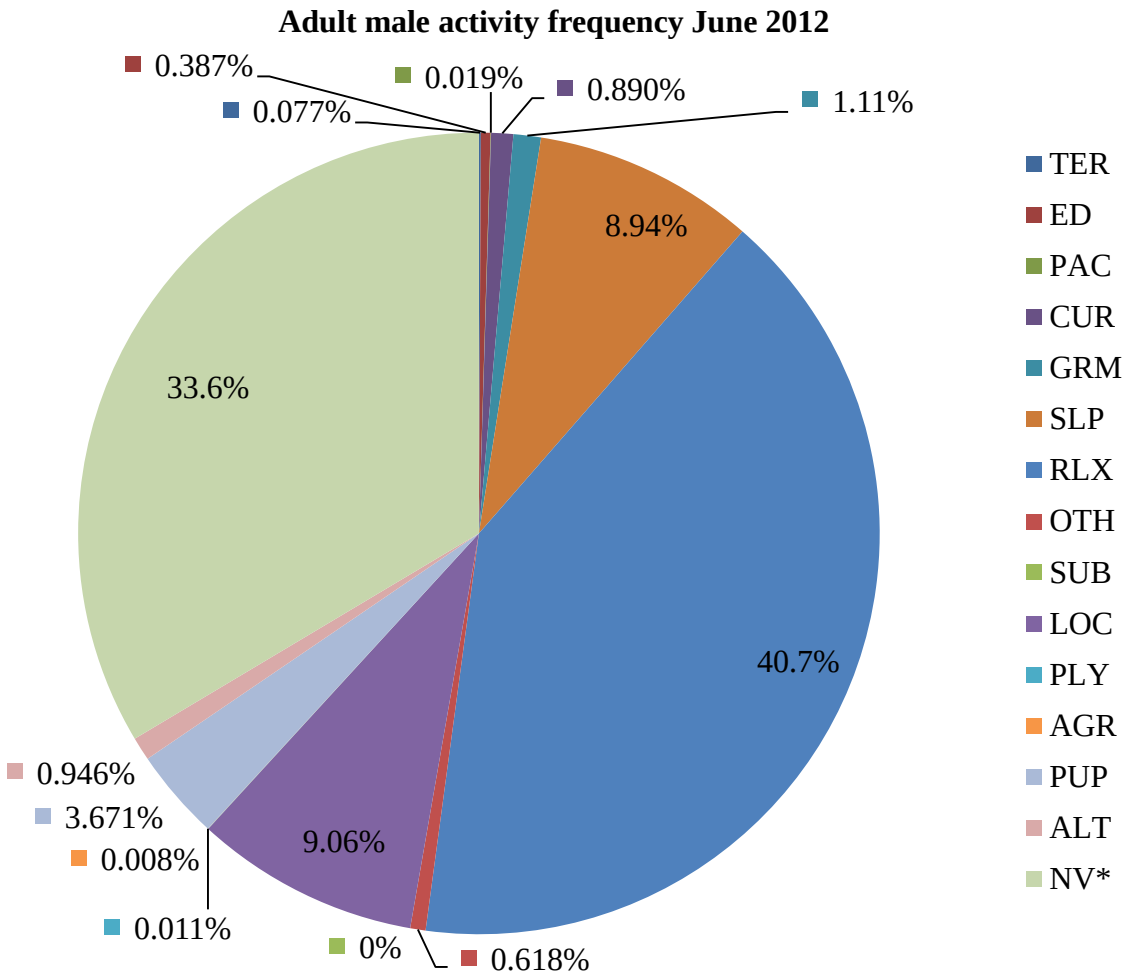

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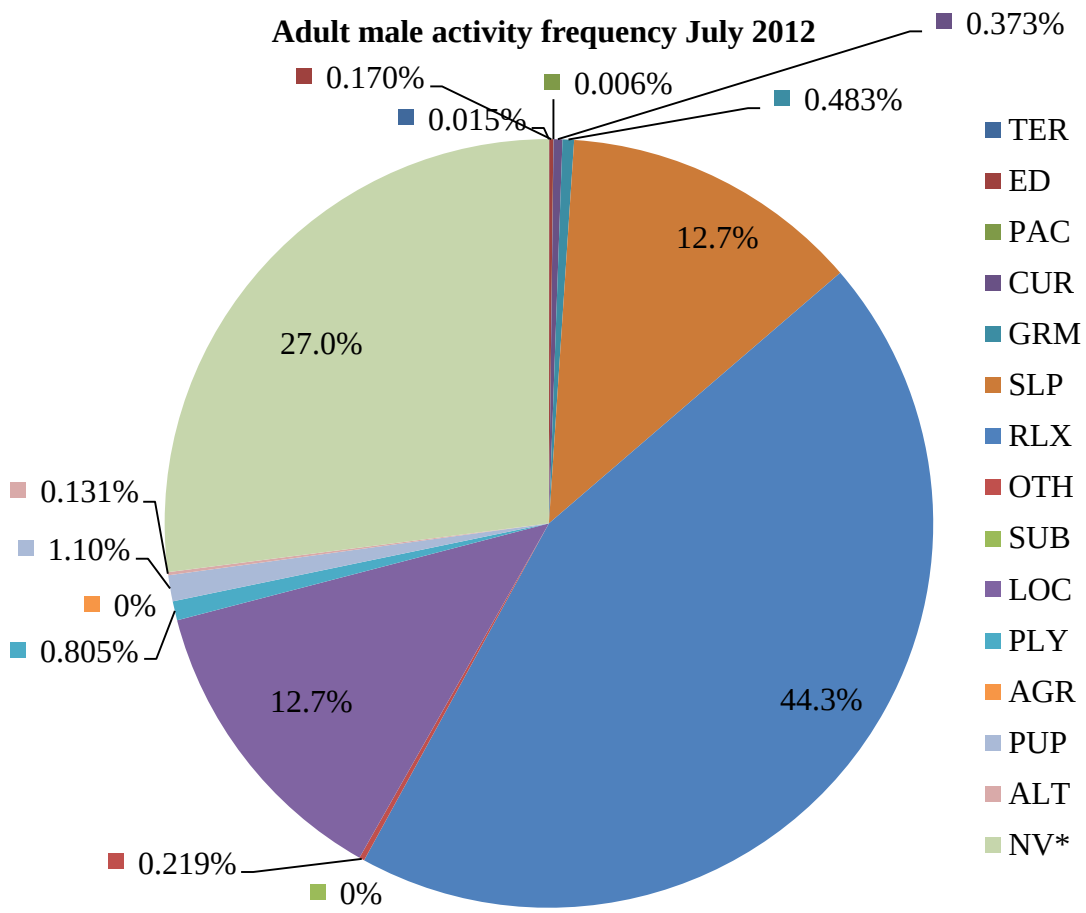

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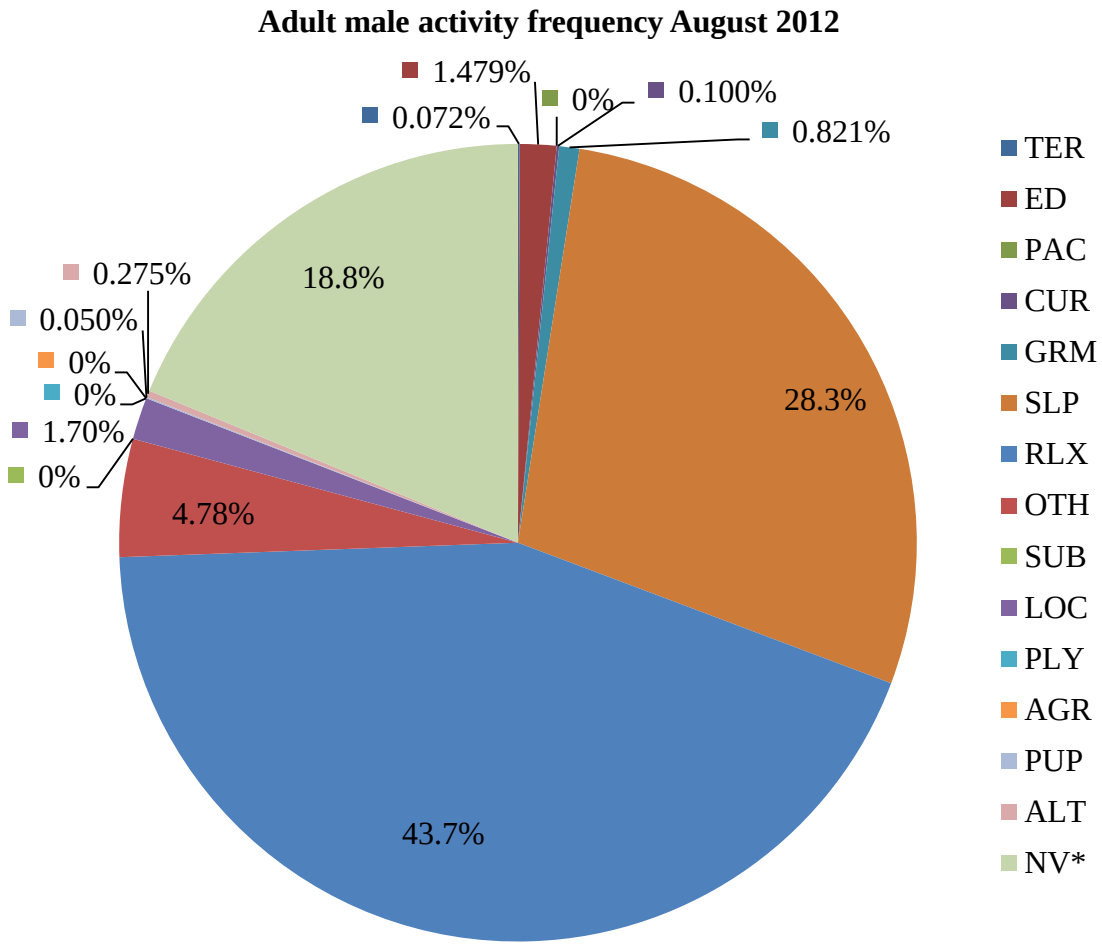

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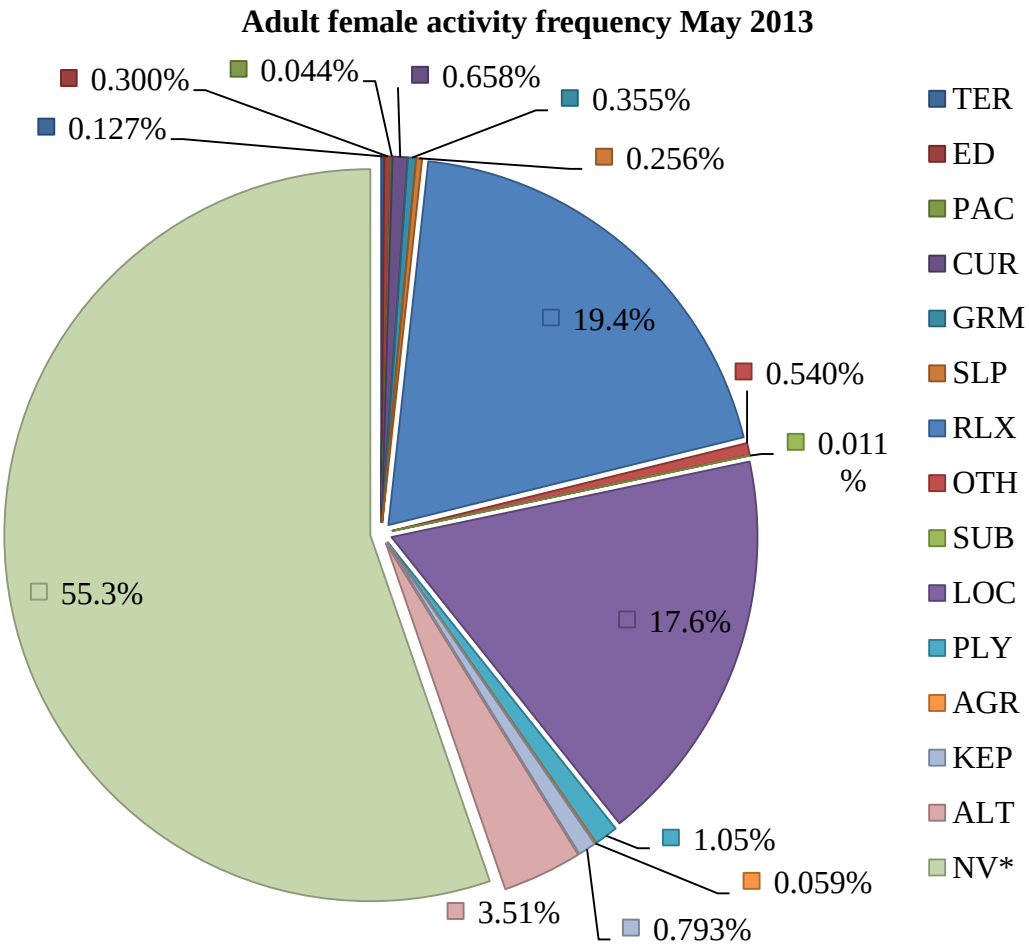
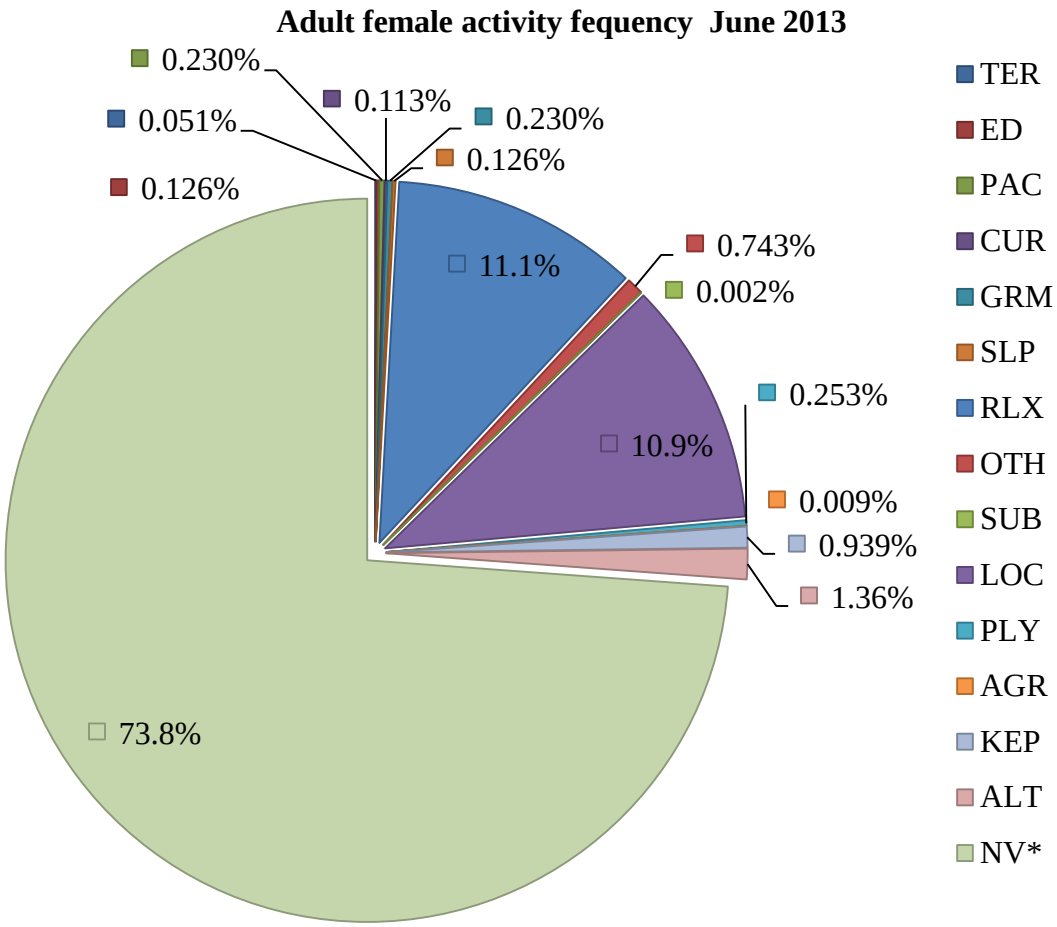
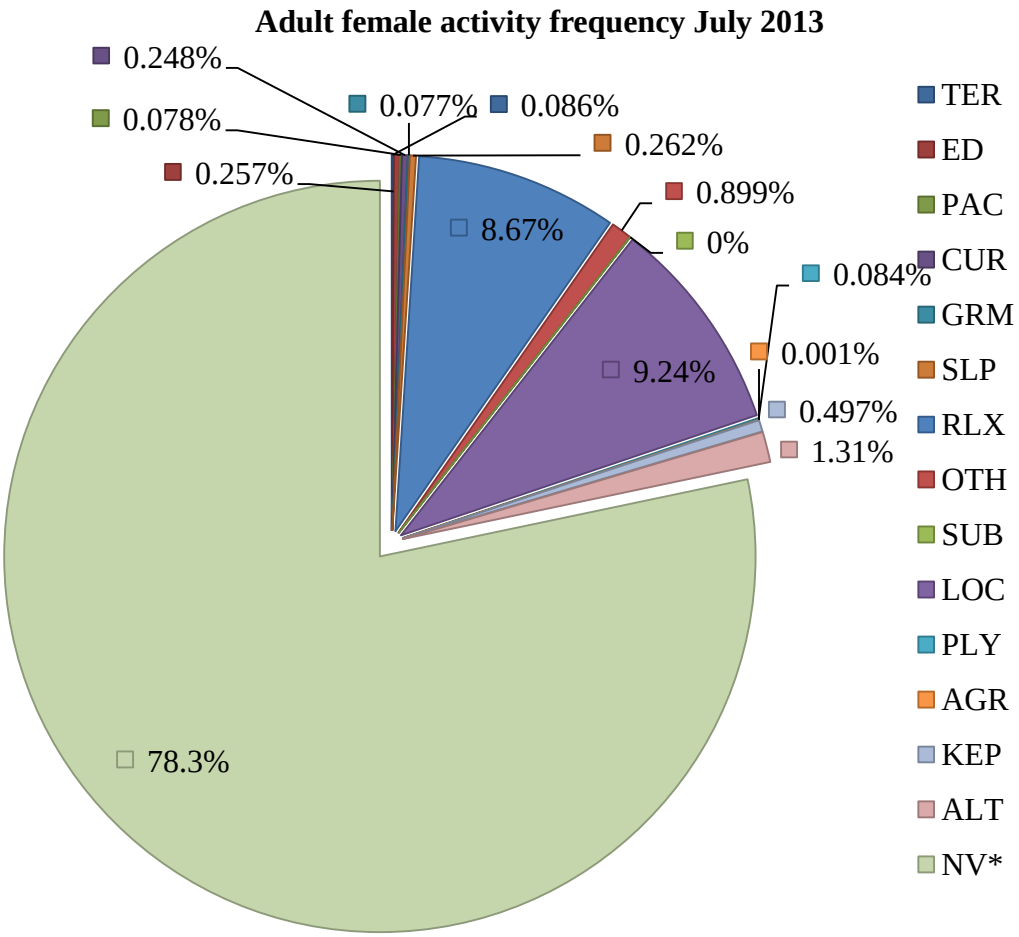


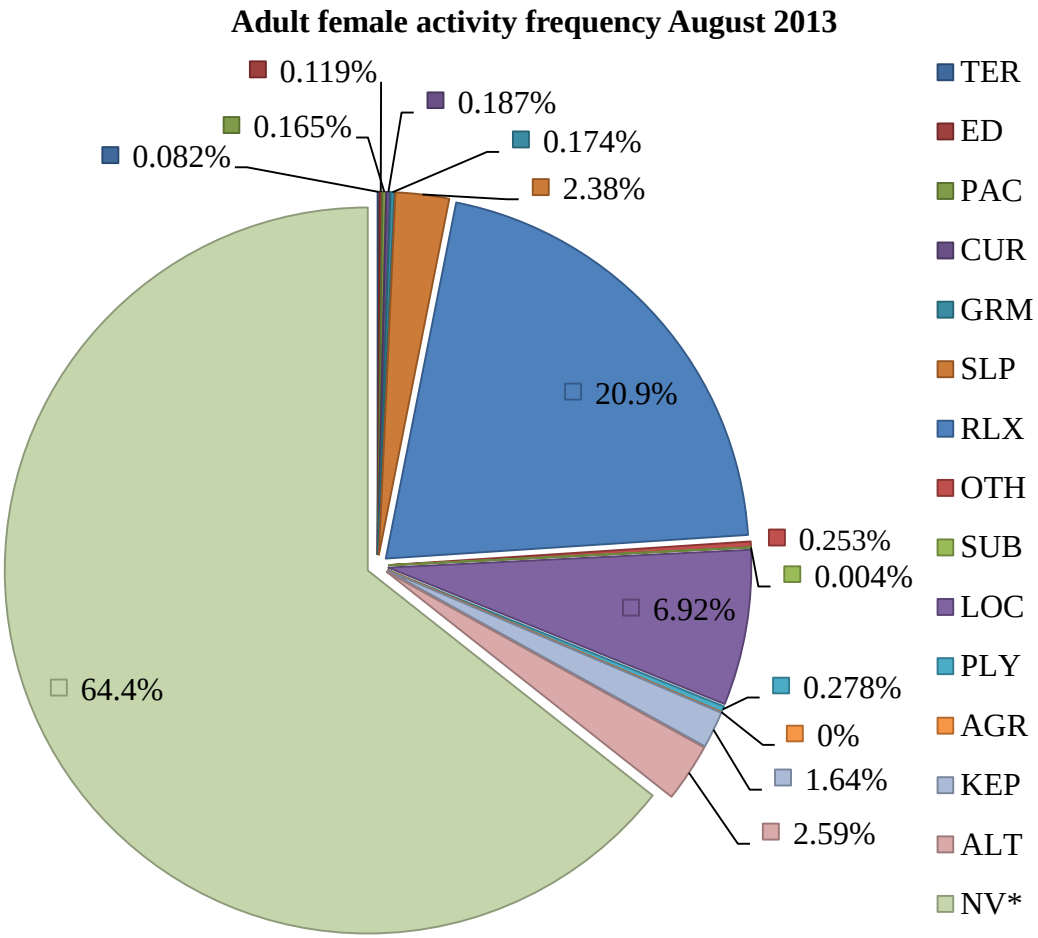
Appendix 9. Adult female red wolf time spent active in May 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



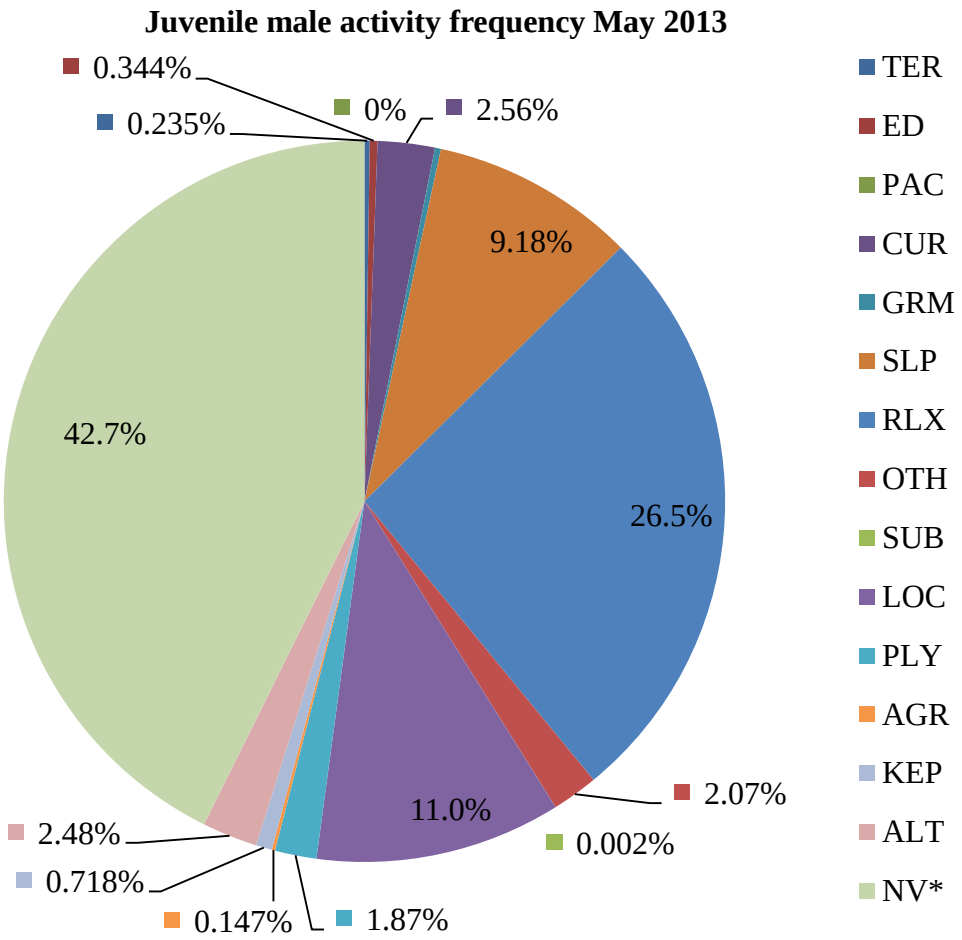
Appendix 10. Adult female red wolf time spent active in June 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



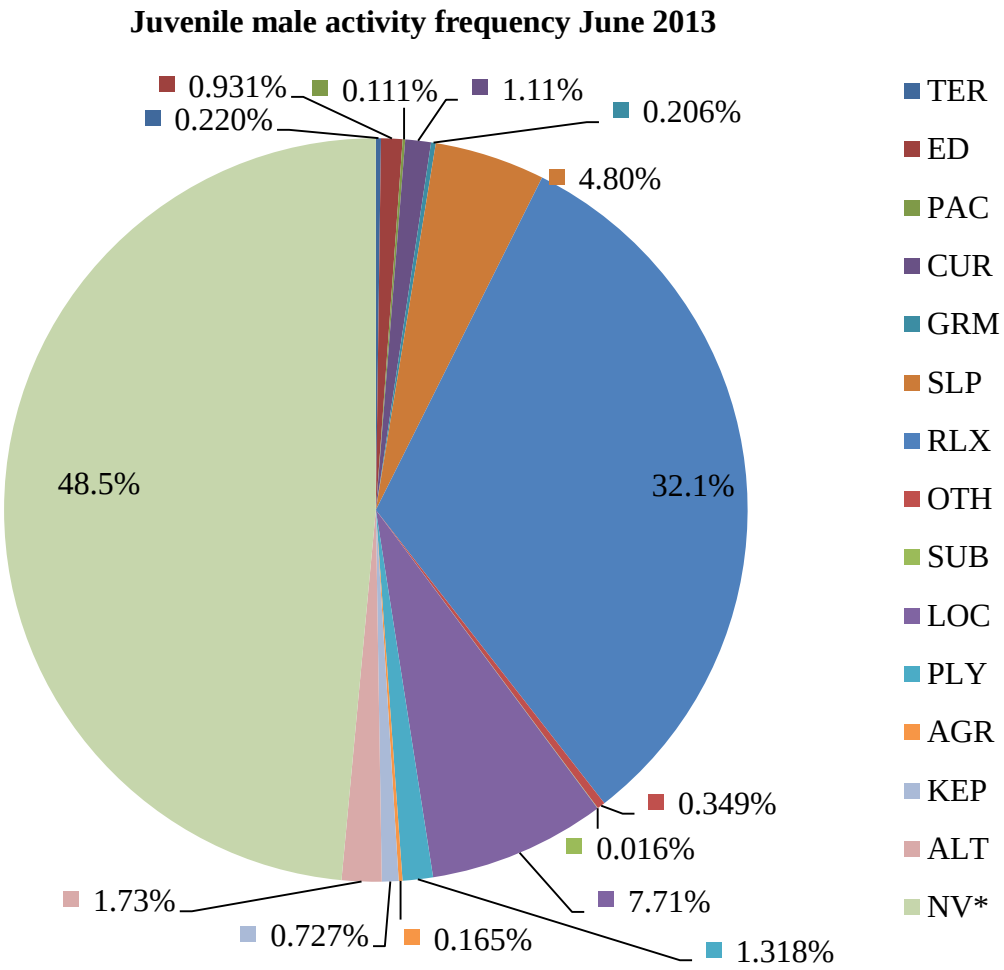
Appendix 11. Adult female red wolf time spent active in July 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



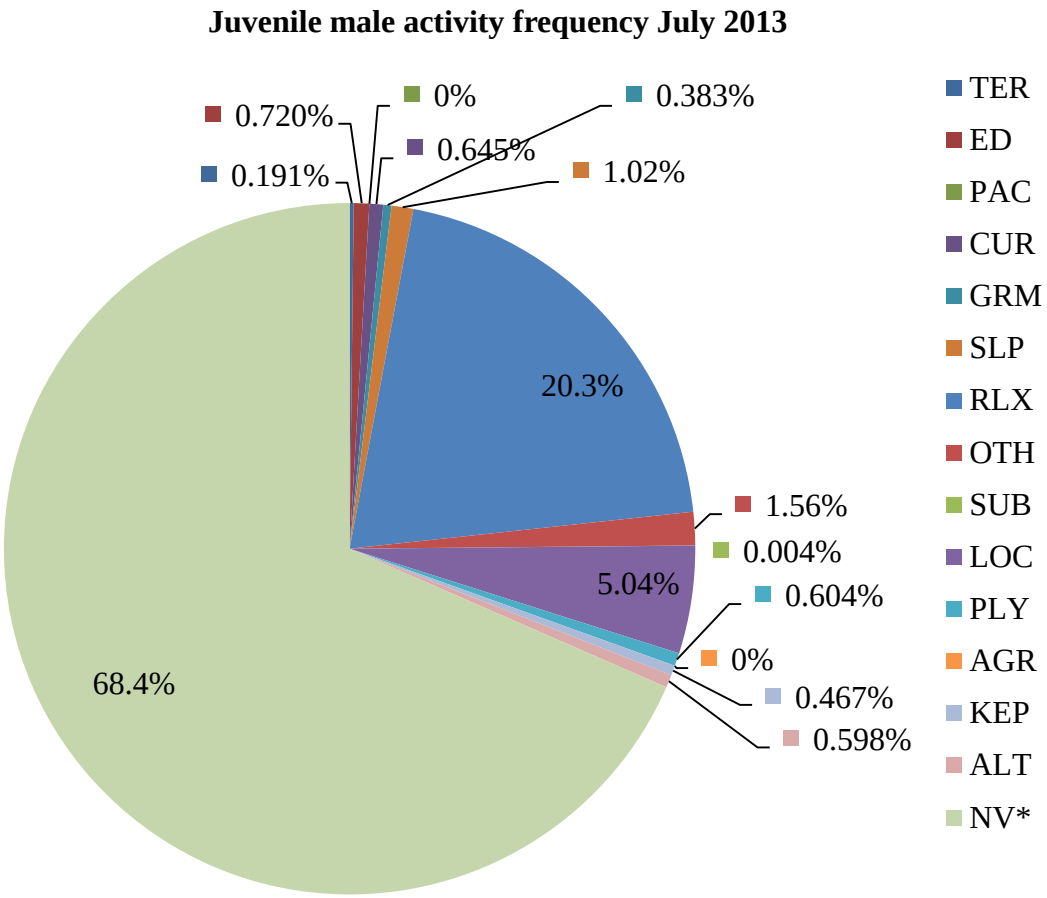
Appendix 12. Adult female red wolf time spent active in August 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



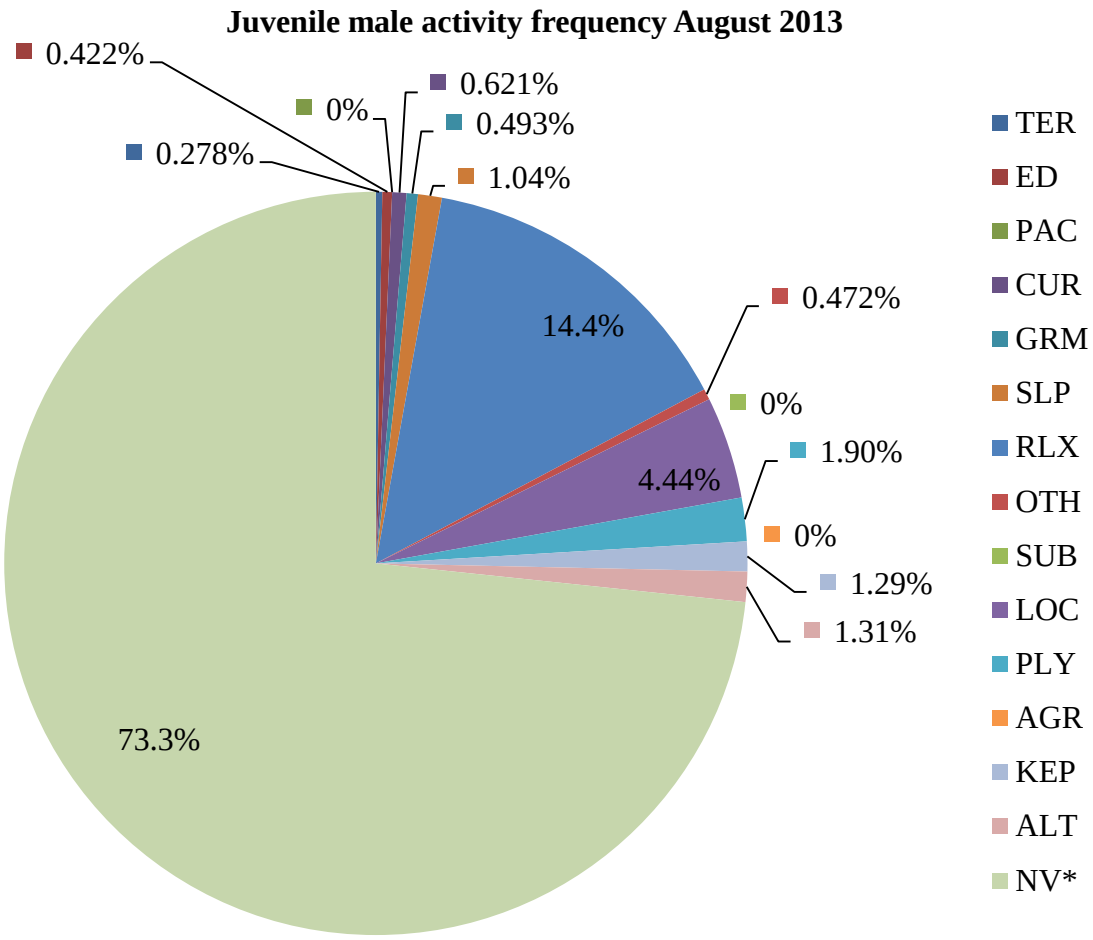
Appendix 13. Juvenile male red wolf time spent active in May 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



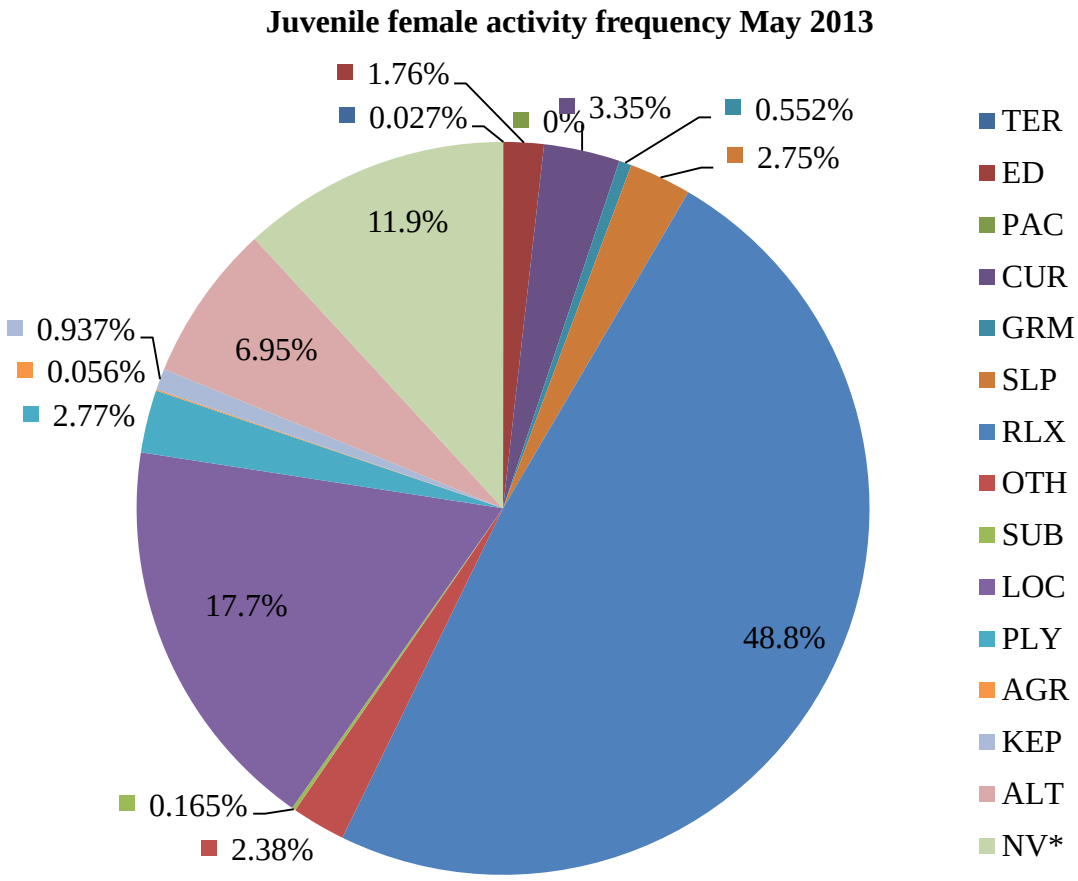
Appendix 14. Juvenile male red wolf time spent active in June 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



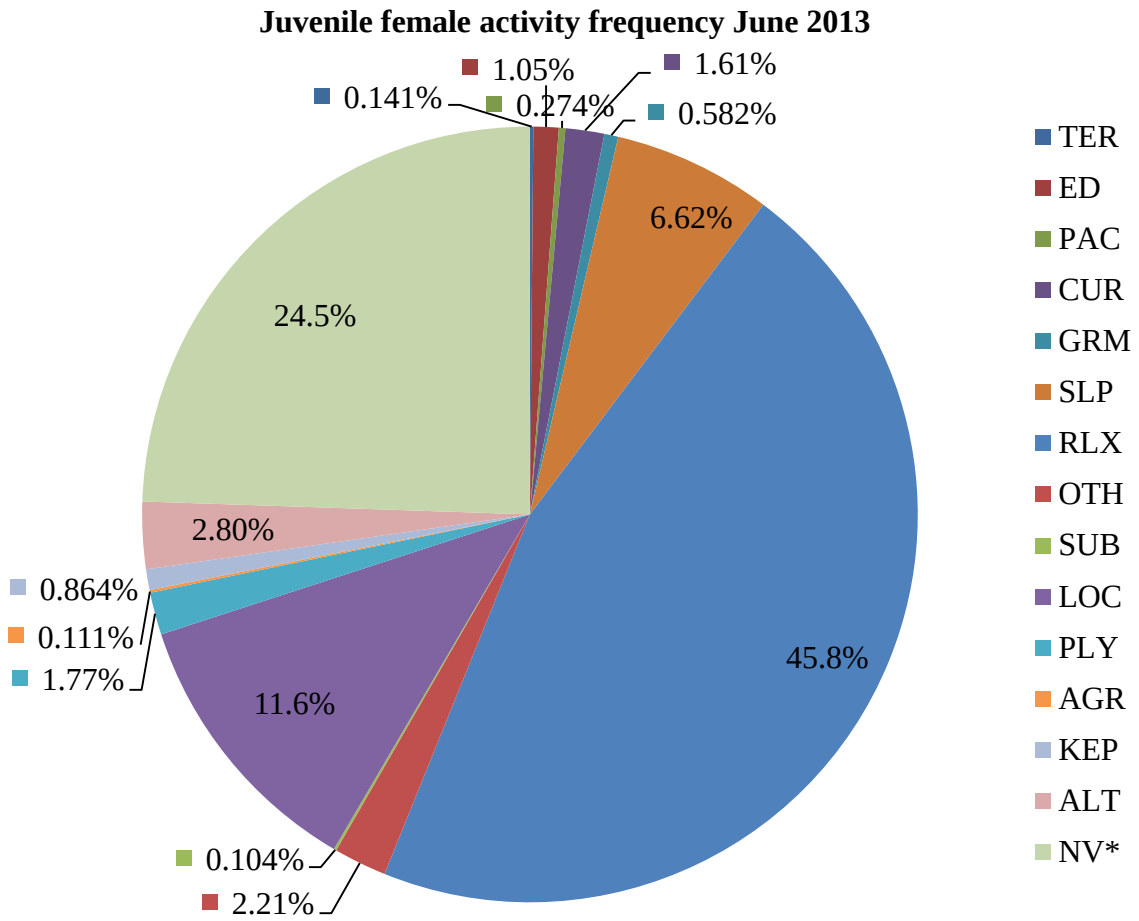
Appendix 15. Juvenile male red wolf time spent active in July 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



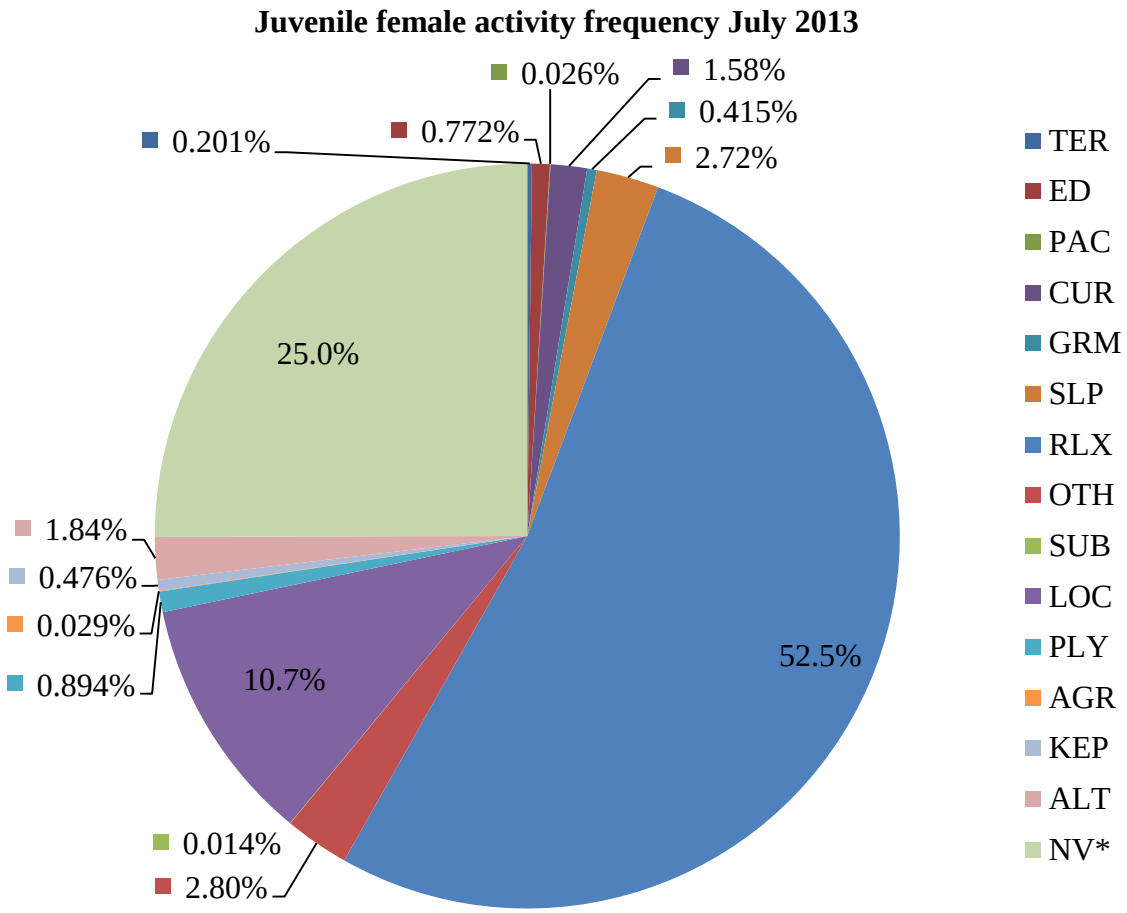
Appendix 16. Juvenile male red wolf time spent active in August 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



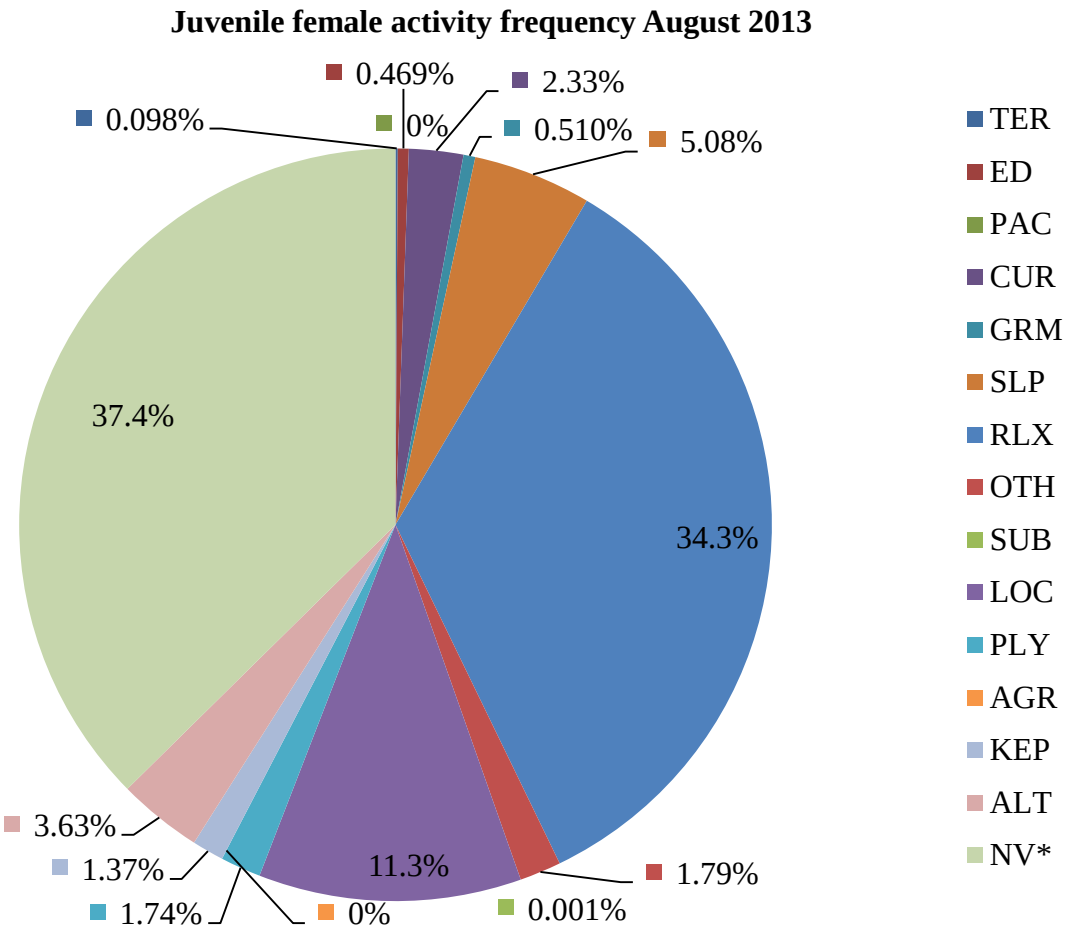
Appendix 17. Juvenile female red wolf time spent active in May 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



Appendix 18. Juvenile female red wolf time spent active in June 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



Appendix 19. Juvenile female red wolf time spent active in July 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.



Appendix 20. Juvenile female red wolf time spent active in August 2013 at the Great Plains Zoo, Sioux Falls, South Dakota. *Behaviors are as followed: TER: territory marking, ED: eating/drinking, PAC: pacing, CUR: curiosity, GRM: grooming, SLP: sleeping, RLX: relaxed state, OTH: other behavior not previously described, SUB: submission/anxiety, LOC: walking/running, PLY: playing, AGR: aggression, KEP: interaction with zookeeper, ALT: alert state, NV: not visible to observer.